fit of the LC function estimating MP under one (T1) or two (T2) times a day milking. The material and methods have been described in another abstract in these proceedings*. The statistical analysis was done with SAS, PROC REG and PROC CORR, to derive a new lactation curve prediction equation (NLC). Total MP was higher for T2 compared to T1 (4070g vs. 3232g). The peak was reached between days 17-18 and 19-20 for T2 and T1 respectively. Persistency, however, was better for T1, which had a higher production after day 29 than T2. The NLC derived in this study added two components; MP on day 4 and day 30, as follows: MP = 804 +9.4 MP4 + 1.4 LW21 + 5.5 MP31. The correlations were 0.92 and 0.96 between the true MP and LC, and true MP and NLC. In addition MP was underestimated on average in 40% of does with LC while NLC overestimated MP in just 4% of does. If MP is a trait to be improved genetically based on a prediction of lactation milk yield, we recommend fitting a regression incorporating multiple measures of daily milk yield like NLC.

Key Words: Lactation, Curve, Rabbits

Ruminant Nutrition: Dairy and Beef

T116 Effects of rumen degradable protein and fiber quality on extracellular proteolytic activity in continuous culture.

D. Hastings, K. Griswold*, T. Kochman, B. Jacobson, and G. Apgar, *Southern Illinois University*.

The effects of rumen degradable protein (RDP) and fiber quality on extracellular proteolytic activity (PA) were examined using a 4 x 4 Latin square with a 2 x 2 factorial arrangement of treatments in dual-flow continuous culture. Factors were level of RDP and quality of fiber, and the treatments were: 1) high RDP (12.4% of dietary DM), high quality alfalfa (156 RFV) (HPHF); 2) high RDP (12.4% of dietary DM), low quality alfalfa (105 RFV) (HPLF); 3) low RDP (10.4% of dietary DM), high quality alfalfa (156 RFV) (LPHF); and 4) low RDP (10.4% of dietary DM), low quality alfalfa (105 RFV) (LPLF). Periods were 10 d and samples were collected daily at 0800 h from fermenter contents and from 24 h effluent composites. Samples were centrifuged (20,000 x *g*, 20 min, 4°C), and supernatant was analyzed for protein content and PA. Using an azocasein assay, PA was defined as units of activity/mg protein, where a unit equaled the change in absorbance at 450 nm/min based on the purified activity of Subtilisin (EC 3.4.21.62). Data were analyzed using SAS MIXED procedures with the model including period, fermenter, RDP, fiber quality, RDP x fiber quality interaction, type of sample (composite vs single time point), and day included as a covariate. Composite samples had greater (P=0.01) protein concentrations and less (P=0.05) PA than single time point samples. Sample protein concentration (mg/mL) was 0.27, 0.40, 0.34, and 0.36, and PA (units/mg protein) was 0.18, 0.16, 0.16, and 0.14 for HPHF, HPLF, LPHF and LPLF, respectively. Dietary RDP concentration had no effect (P>0.05) on sample protein concentration or PA. There was a RDP x fiber quality interaction for HPHF protein concentration to be less (P<0.01) than all other treatments. Decreasing fiber quality increased (P<0.01) protein concentration, and in turn, decreased (P=0.05) PA. These results suggest dietary fiber quality may have a greater influence on ruminal extracellular proteolytic activity than dietary RDP.

Key Words: RDP, Fiber quality, Proteolytic activity

T117 Relative transite time of chyme between duodenal and jejunal segments of the small intestine of cattle.

V. M. Gonzalez[1], E. G. Arellano[1], G. Mendoza[1], F. G. Monge[1], A. Plascencia*[1], E. Silva-Pena[1], C. Vasquez[1], and R. A. Zinn[2], [1]*Universidad Autonoma de Baja California, Mexico,* [2]*University of California, Davis*.

Two steers (228 ± 4.5 kg) were equipped with cannulas (25 mm ID) in the small intestine to measure transit time of chyme within the duodenum, and jejunum. Sites for cannula placement were 1) proximal duodenum (6 cm from the pyloric sphincter); 2) duodenal-jejunal juncture (10 cm from the duodenocolic fold) and 3) distal ileum (22 cm from ileocecal valve). Steers were fed 5.75 kg of alfalfa hay (ground to pass through a 7.6 cm screen). Transit time was measured during three consecutive days using aniline dye, pulse-dosed via the duodenal and jejunal cannulas. Subsequently, steers were euthanazed. Site of cannula placement were confirmed using anatomical reference and tissue analysis. The small intestine was then dissected and measured. Transit time (time required between infusion of aniline dye into the proximal duodenal cannula and its appearance at the duodenal-jejunal and distal ileal cannulas was 2.56 ± 0.06 and 176 ± 4.21 min, respectively. Length of duodenal, jejunal, and ileal segments of the small intestine were 135 ± 4, 2730 ± 27 and 110 ± 1 cm, respectively. Transit time of chyme within the duodenum and jejunum averaged 46 and 14 cm/min, respectively. Considering that the duodenum represents less of 5% of total length of small intestine, that duodenal transit time is threefold faster than that of the rest of the small intestine, and that pancreatic and bile secretions into the duodenum occur midway along its length, we conclude that the duodenum plays a minor role in net nutrient absorption from the small intestine.

Key Words: Small intestine, Transite time, Cattle

T118 Effects of feeding a slow-release urea on ruminal nitrogen dynamics in steers.

K. C. Hanson*[1], S. E. Kitts[1], N. B. Kristensen[1], D. E. Axe[2], and D. L. Harmon[1], [1]*University of Kentucky, Lexington,* [2]*IMC, Lake Forest, IL*.

Twelve ruminally-cannulated steers (529 ± 11 kg BW) were used to determine the effect of feeding a slow-release urea on ruminal N dynamics. Steers were equally divided into two groups: control (feed grade urea; FGU) or slow-release urea (SRU). Steers were fed corn silage plus 10% supplement at 1.29% BW for 35 d. Diets were formulated to be isonitrogenous and contain 12.5% crude protein. All supplemental N was from FGU or SRU (42% of N intake). Blood was collected via jugular vena-puncture on d 33 and plasma was harvested for analysis of urea, glucose, glutamate, and glutamine. On d 34, ruminal fluid was collected every two h for ten h post-feeding and analyzed for NH_3, VFA, and pH. Samples taken 4 h post-feeding were analyzed for urease activity. On d 35, an in situ study determined the release of SRU from nylon bags suspended in the rumen. Nylon bags containing SRU were suspended for 0, 2, 4, 6, 8, 12 and 24 h. Upon removal, bags were rinsed and dried at 55° C before analysis for N content. Body weights and DM intakes were similar. Ruminal pH (6.5) was not affected by treatment but ruminal ammonia was less (8.9 vs. 14.1 mM; P < 0.02) and ruminal urease activity was greater (149 vs. 89 mmol/(min·mL rumen fluid); P < 0.06) in steers consuming SRU. In situ rates of SRU degradation were not affected by treatment (6.28 %/h), indicating that the ruminal microbes did not adapt during 35 d of feeding SRU. Plasma glucose concentrations were less (50 vs. 60 mg/dL; P < 0.02) in steers fed SRU. Plasma urea (5.1 mM), glutamine (255 μM), and glutamate (174 μM) concentrations were not affected. Ruminal VFA molar proportions or concentrations were not affected by treatment. These results demonstrate that SRU possesses the ability to slowly release N in the ruminant.

Key Words: Ruminant, Urea, Nitrogen

T119 Effect of a novel hexadecatrienoic acid from marine algae (*Chaetoceros*) and olive oil on methane production by ruminal fluid in vitro.

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Since methane emissions by ruminants are a major loss of feed energy and also contribute to global warming, there is considerable interest in decreasing ruminal methanogenesis. Fats and oils usually decrease methane production both in vitro and in vivo, although they also inhibit fermentation. We studied the effects of a novel hexadecatrienoic acid ($C_{16:6,9,12}$) and of olive oil on ruminal fluid 24 h-batch in vitro fermentation. The hexadecatrienoic acid was purified from a marine algae (*Chaetoceros*) at the Univ. of Hawaii-Manoa. Initial concentrations of both additives were 0, 0.5, 1, and 2 mg/L (n = 4). The hexadecatrienoic acid linearly decreased (P < 0.01) methane production by 96%, while olive oil did not affect it. The hexadecatrienoic acid also caused (P = 0.02) a 6-fold hydrogen accumulation. Production of carbon dioxide was linearly decreased (P < 0.01) by the hexadecatrienoic acid by 46%, while olive oil increased carbon dioxide production linearly (P = 0.03) by 17%. Neither additive had an effect on final pH. Apparently fermented OM, as estimated from the VFA stoichiometry, was linearly decreased (P < 0.01) by the hexadecatrienoic acid by 47%, while olive oil increased it linearly (P = 0.03) by 5%. The hexadecatrienoic acid linearly decreased (P < 0.01) acetate molar percentage from 69 to 55%,

tended to decrease (P < 0.10) butyrate molar percentage, and increased (P < 0.01) propionate molar percentage from 21 to 36%. Olive oil linearly decreased (P < 0.01) acetate molar percentage from 70 to 66%, and increased (P = 0.02) propionate from 22 to 23% and butyrate from 6.1 to 9.5%. The hexadecatrienoic acid linearly decreased (P = 0.04) ammonia concentration by 21%, while olive oil did not affect it. The hexadecatrienoic acid was a strong inhibitor of ruminal methanogenesis, but it decreased fermentation, and caused some hydrogen accumulation. Olive oil could be used to increase dietary energy without negatively affecting fermentation.

Key Words: Methane, Rumen, Oil

T120 Short-term energy and protein supplementation affects ammonia, urea and glucose flux across portal-drained viscera (PDV) and liver in Holstein steers. J. H. Eisemann*[1], J. E. Ramirez[1], K. E. Govoni[2], S. A. Zinn[2], and G. B. Huntington[1], [1]*North Carolina State University,* [2]*University of Connecticut.*

The objective was to determine the effect of dietary supplements on plasma concentration of IGF-I, IGF binding proteins (BP) and on net splanchnic flux of glucose, urea, and ammonia (NH3). Eight Holstein steers (212 ± 5 kg) with catheters in the hepatic portal vein, a branch of the hepatic vein, a branch of the cranial mesenteric vein and an artery were fed a basal, low ME and low CP diet for 3 wk (4 kg/d, 8.84 Mcal ME, 424 g CP) before receiving one of two supplements similar in ME but different in protein content. The high protein supplement (HIPRO, 4 steers, 400 g/d soybean meal:corn gluten meal 1:1.5 (w:w), 1.37 Mcal ME, 210 g CP) or low protein supplement (LOPRO, 4 steers, 385 g/d corn grain, 1.29 Mcal ME, 30 g CP) was fed for 7 d. Steers were fed equal-size meals every 12 h. Plasma concentrations of NH3, urea N, and glucose, plasma flow (indicator dilution) and net flux (mmol/h, venoarterial differences x plasma flow) through PDV and liver were measured hourly for 12 h during the basal period and after 7 d of supplementation. Plasma IGF-I, BP2 and BP3 concentrations were measured in arterial samples taken 4 h post-feeding. Means ± SEM for the basal period (8 steers) were 0.214 ± 0.018 mM, 1.53 ± 0.18 mM, and 4.34 ± 0.09 mM for arterial NH3, urea N and glucose, 386 ± 23 L/h and 470 ± 24 L/h for PDV and liver plasma flow, 46 ± 3.4 and 48 ± 3.7 for net PDV release and net liver uptake of NH3, 38 ± 5.7 and 50 ± 8.5 for net PDV uptake and net liver release of urea N, 30 ± 3.3 and 121 ± 13.7 for net PDV uptake and net liver release of glucose, 108 ± 13 ng/mL, 22 ± 3 arbitrary units (AU), and 24 ± 2 AU for arterial IGF-I, BP2 and BP3. Supplement minus basal differences in concentration or net flux within steer were used to assess response (P < 0.05). Supplement NH3 responses were due to increased PDV release and liver uptake with HIPRO. Supplement urea responses were due to increased PDV uptake and liver release with HIPRO. Supplement glucose responses were due to a combination of decreased PDV uptake and liver release with LOPRO and increased PDV uptake and liver release with HIPRO (P < 0.13 for liver). Supplement did not affect plasma concentration of IGF-I, BP2 or BP3. Ruminal degradation of supplemental protein and gluconeogenesis from absorbed amino acids likely explain observed responses.

Key Words: Protein, Energy, Steers

T121 Is ruminal biotin availability decreased by low pH? O. Rosendo*[1], D. Bates[1], C. R. Staples[1], L. R. McDowell[1], R. J. McMahon[1], W. M. Seymour[2], and N. Wilkinson[1], [1]*University of Florida, Gainesville, Fl.,* [2]*Roche Vitamins, Inc., Parsippany, NJ.*

The objective of this study was to measure biotin availability for ruminal microorganisms to degrade forage fiber in media pH of 6.7 and 5.3. In vitro 24-h Tilly and Terry incubations of alfalfa hay (54.8% NDF), bermudagrass hay (76.7% NDF), or corn silage (47.6% NDF) (OM basis) were conducted without adding biotin to media. Ruminal inocula was obtained from a lactating Holstein cow fed a diet composed mainly of corn silage, alfalfa hay, whole cottonseed, ground corn, and soybean meal. Three tubes for each pH by forage source were incubated with a 4:1 ratio of McDougall's buffer and ruminal fluid for 0 and 24 h at 39°C for each fermentation run. Three fermentation runs were conducted. Tube contents at 0 and 24 h were centrifuged for 20 min at 20,000 x g (4 °C) and aliquots of the supernatant (1 ml) were centrifuged at 13,000 x g for 10 min to obtain a clear cell-free supernatant. Biotin concentrations in cell-free rumen fluid at 0 and 24 h were assayed as avidin binding substances, and analyzed using the GLM procedure of SAS. The model included factors for run, forage, pH, hour, and interactions. Mean biotin concentration was higher in media from bermudagrass (12.8 nM) than that from alfalfa (10.1 nM) but was not different from that from corn silage (11.7 nM). Interactions of forage source by pH (P = 0.32) and forage source by hour (P = 0.14) were not significant. The magnitude of increase in biotin concentration from 0 to 24 h of fermentation averaged across forage sources varied with pH (pH by hour interaction, P = 0.0001). Biotin concentration in media increased from 0 to 24 h incubation by 25 and 104% for pH 6.7 (7.9 to 9.9 nM) and 5.3 (9.3 to 19.0 nM), respectively. Almost no NDF digestion occurred at a pH of 5.3 compared to a pH of 6.7 (13.2 vs. 35.6%). Results suggest that biotin was less utilized at pH 5.3 likely due to a decrease in the growth of cellulolytic microbes. At pH of 6.7, equilibrium between biotin producers and utilizers may have prevented accumulation of biotin in the medium.

Key Words: Biotin, In vitro, pH

T122 Ammonia production rate from five protein sources. E. B. Venable* and M. S. Kerley, *University of Missouri-Columbia.*

The purpose of this study was to measure the rate of ammonia production by ruminal fermentation of five common protein sources. It is possible to minimize nitrogen waste in the rumen if excessive ammonia production does not occur. Ammonia consumption in the rumen can be estimated based upon microbial growth and efficiency. Matching ammonia production to ammonia consumption requires knowledge of ammonia production rates from the degradable protein sources, which was the objective of our research. An in vitro batch culture was used to ferment five sources of rumen degradable protein (RDP) to ammonia. Those sources were soybean meal (SBM), soyhulls (SH), corn gluten meal (CGM), corn gluten feed (CGF), and dried distiller's grains with solubles (DDGS). Rumen fluid and McDougall's buffer was mixed to .1 L volume at a ratio of 1:4 with 2.5 g of RDP source added. Samples were taken at 1, 2, 4, 8, 10, 12, 16, 24, and 30 hours and analyzed for ammonia concentration. The rate of ammonia N released per hour per gram of protein was 0.3, 0.5, 0.4, 0.3, and 0.9 for DDGS, CGF, CGM, SH and SBM, respectively. These values are a function of RDP mass and fermentation rate. When rate was expressed as a percentage of the fermented protein fraction, ammonia N production rate was 3.2, 3.0, 3.2, 2.6, and 3.5% for DDGS, CGF, CGM, SH, and SBM, respectively. Concluded from this research was that proteolytic activity against degradable protein followed substrate limiting kinetics with ammonia N production rates similar across sources of protein studied. Therefore, ammonia production could be calculated by an empirical equation based upon the degradable protein mass consumed.

Key Words: Protein, Ammonia

T123 Influence of abomasal carbohydrates on small intestinal sodium-dependent glucose co-transporter activity and abundance in steers. S. M. Rodriguez*[1], K. C. Guimaraes[1], J. C. Matthews[1], K. M. McLeod[1], R. L. Baldwin[2], and D. L. Harmon[1], [1]*University of Kentucky, Lexington,* [2]*USDA, ARS, Beltsville, MD.*

There is conflicting data concerning the extent of up-regulation of SGLT1 in response to carbohydrate in the small intestinal lumen. An experiment was conducted to determine the effect of glucose and starch hydrolysate on activity and abundance of sodium-dependent glucose co-transporter 1 (SGLT1) in the small intestine of steers. In a randomized complete block design, forty crossbred beef steers (243 ± 2 kg BW) were fed 0.163 Mcal ME/(kg $BW^{0.75}$·d) (1M) or 0.215 Mcal ME/(kg $BW^{0.75}$·d) (2M) or they were fed 0.163 Mcal ME/(kg $BW^{0.75}$·d) and infused for 35 d into the rumen (R) or abomasum (A) with starch hydrolysate (S) or into the abomasum with glucose (G). Steers were slaughtered, and brush-border membrane vesicles were prepared from the small intestinal samples obtained from five equidistant sites along the intestine. The maltase activity, Na^+ dependent glucose transport capacity and SGLT1 protein abundance of the vesicles were determined. Maltase specific activity in vesicles and homogenates differed with intestinal sampling site (quadratic; P < 0.001). The AG treatment yielded a higher intestinal maltase specific activity (38 nmol glucose/(mg protein#min) compared to the AS, RS, 1M or 2M treatment 34, 26, 23, and 23 nmol glucose/(mg protein#min), respectively (SEM=3; P = 0.02). Sodium dependent glucose uptake was not affected by treatment, but decreased distally along the intestine (P < 0.001). There was no effect

of treatment on SGLT1 protein abundance, but SGLT1 protein abundance increased from the duodenum to the ileum (linear; P = 0.05). The inverse relationship between glucose uptake and SGLT1 abundance suggests that regulation of glucose transport capacity is complex, involving factors other than SGLT1 abundance.

Key Words: Glucose, Ruminant, Transport

T124 Effects of combinations of ethyl 2-butynoate and crotonic acid or 3-butenoic acid on ruminal degradability and microbial efficiency in vitro. E. M. Ungerfeld*, S. R. Rust, and R. Burnett, *Michigan State University, East Lansing, MI, USA*.

It is desirable to decrease methane formation in the rumen because it represents an energy loss and contributes to global warming. Ethyl 2-butynoate has been shown to inhibit ruminal methanogenesis in vitro, but also had adverse consequences on fermentation. As crotonic acid and 3-butenoic acid seemed to stimulate fermentation, it was hypothesized that they could relieve the fermentation constraints caused by ethyl 2-butynoate. In 1000 mL-Erlenmeyer flasks, 750 mL of a 4:1 mixture of buffer and ruminal fluid was delivered under O_2-free CO_2, and 6 g of grass hay used as substrate. Ethyl 2-butynoate at 0, 4, and 8 mM initial concentration was combined with crotonic acid (Exp. 1) or 3-butenoic acid (Exp. 2) at 0 or 4 mM (n = 3). Flasks were incubated at 39 °C for 72 h. ^{15}N was used as a microbial marker. In Exp. 1, ethyl 2-butynoate decreased N (P = 0.04; quadratic response) and OM (P = 0.04; quadratic response) degradability from 48 to 19%, and from 36 to 31%, respectively. Ethyl 2-butynoate increased the efficiency of microbial CP (P < 0.01) and OM (P = 0.02) synthesis by 58 and 47%, respectively. Crotonic acid had no effects on OM or N degradability, or on microbial efficiency of OM or CP synthesis. In Exp. 2, ethyl 2-butynoate decreased (P < 0.01) N degradability from 71 to 57%, and did not affect OM degradability. Ethyl 2-butynoate tended to increase the efficiency of microbial CP (P = 0.06) and OM (P = 0.08) synthesis by 28 and 18%, respectively. 3-Butenoic acid had no effects on OM or N degradability, but tended to improve the microbial efficiency of CP (P = 0.12) and OM (P = 0.08) synthesis by 12 and 13%, respectively. Both 3-butenoic and crotonic acid were ineffective in improving fermentation. It remains to be elucidated if the improvement in the microbial efficiency of OM and CP synthesis caused by ethyl 2-butynoate was a consequence of the change in H dynamics caused by the inhibition of methanogenesis, or a particular effect of ethyl 2-butynoate on some microorganisms.

Key Words: Methane, Rumen, Degradability

T125 Amino acid profiles of tropical forages and of residues after incubation in the rumen and phosphate borate buffer corrected by the ADIP amino acid profile. L. Miranda[1], N. Rodriguez[2], R. Sainz*[3], E. Pereria[4], M. Gontijo Netto[5], C. Veloso[6], and P. Fernandes[7], [1]*FEAD-Minas, Brazil,* [2]*Universidade Federal Minas Gerais, Brazil,* [3]*University of California- Davis, USA,* [4]*Universidade Estadual Oeste Parana, Brazil,* [5]*EMBRAPA Gado de Corte, Brazil*.

Amino acid (AA) profiles of several feed protein fractions were determined for foliage from leucaena (Leucaena leucocephala), perennial soy (Neonotonia wightii), cassava (Manihot esculenta), rami (Boehmeria nivea) and pigeon pea (Cajanus cajan) using in situ and in vitro procedures. Fractions included total feed protein; phosphate-borate buffer (PBB) insoluble residue; and (rumen) undegradable intake protein (UIP), the residue after 18h rumen incubation in nylon bags, corrected by the ADIP amino acid profile. These were analyzed by HPLC after acid hydrolysis or peroxidation followed by acid hydrolysis. Amino acid concentrations were determined for three replicates of each forage and their corresponding residues, in a totally randomized design. Data were analyzed by analysis of variance (PROC GLM), and means were compared using Tukey's test with a 5% significance level. Protein fractions B2 and B3, representing available insoluble amino acids, were expressed as a % of crude protein of the corresponding residue. There were differences in the amino acid profiles of the original forage and PBB residues, as well as after 18h of rumen incubation for all forages except for pigeon pea. In rami only the content of Lys was higher (P > 0.05) in PBB than in the original forage. For leucaena, several AA (EAA, Phe, His, Iso, Leu, Lys, and Thr) contents differed between the original forage and the UIP residue. The same was true for perennial soybean (EAA, Leu, Lys, Met, and Val) and cassava (Arg, Iso, Phe and Lys). If the insoluble fraction has higher chances of bypassing rumen fermentation, the amino acid profiles of the insoluble fraction and of non-degradable amino acids would be similar. However, the present study identifies differences between the amino acid profiles of the PBB insoluble residue and of residues after 18h of rumen incubation.

Key Words: Amino acid, Tropical forage, ADIP amino acid profile

T126 Contribution of degraded starch to the prediction of fermentable organic matter for ruminants. A. Offner* and D. Sauvant, *INA P-G INRA, Paris, France*.

In ruminants, the amount of organic matter truly fermented in the rumen (**RFOM**, % of DM) has many consequences, especially on microbial growth. The objective of this study was to examine the influence of starch degraded in the rumen on prediction of RFOM. A database on starch digestion in ruminants was built from 87 references and included 316 treatments. Data were analyzed by GLM including the *study* effect. First, RFOM measured *in vivo* was compared to RFOM predicted by the CNCPS and INRA models. The CNCPS tended to overestimate RFOM (+15.8 % of DM). Variations in RFOM within study were predicted by the CNCPS with a residual standard deviation (*rsd*) of 3.51 % of DM. The RFOM was estimated by INRA from digestible organic matter (**DOM**), ruminally undegraded protein (**RUP**) and ether extract (**EE**): RFOM = DOM - RUP - EE. In this case, variations in RFOM within study were predicted with a *rsd* of 3.15 % of DM. These results confirmed the need for a more accurate prediction of RFOM in feeding systems. This could be achieved by including ruminally degraded starch (**RDS**, % of DM) in RFOM predictions: RFOM = 42.2 + 0.59 × RDS (n = 200, n_{exp} = 85, R^2 = 0.94, rsd = 3.4 % of DM, sd_{exp} = 14.8 % of DM). Despite the correlation between DOM and RDS (r = 0.65), the INRA equation did not accurately account for RDS effects. This equation can be adjusted: RFOM = 10.6 + 0.69 × RFOM $_{INRA}$ + 0.29 × RDS; variations in RFOM within study were then predicted with a *rsd* of 2.99 % of DM. These results emphasized the significant and large influence of RDS on RFOM. Such equations could be of a practical interest in feeding systems, allowing better estimation of RFOM for various feeds.

Key Words: Rumen, Fermentable organic matter, Starch

T127 Using Synchrotron infrared microspectroscopy to probe molecule chemical difference between two types of barley with distinguished biodegradation behaviors. P. Yu*[1], J. J Mckinnon[1], C. Christensen[2], M. D. Drew[1], B. G. Rossnagel [3], and D. A Christensen[1], [1]*Department of Animal and Poultry Science, University of Saskatchewan,* [2]*BioMedical Imaging Group,* [3]*Department of Plant Sciences, University of Saskatchewan*.

Feed-type barley (cv. Valier) and malting-type barley (cv. Harrington) markedly differ in degradation behavior in ruminants. Harrington barley is higher but Valier barley in the rate and extent of rumen degradation. A high degradation of barley may result in digestive disorders in ruminants when feeding barley-based concentrate diets. Traditional "wet" chemical analysis methods cannot detect such distinguished biological differences mainly because the chemical structures and molecular characteristics of intrinsic structures of plant are destructed during the processing for analysis. Synchrotron Fourier transform infrared microspectroscopy (S-FTIR) is an advanced and newly emerging bioanalytical microprobe capable of exploring the molecular chemistry within microstructures. The objective was to use the non-invasive S-FTIR to explore and identify molecular chemically difference on ultra-structural matrix of endosperm tissue. Results show that infrared absorbance intensity of starch to protein ratio was different (4.12 vs. 2.78 for Harrington and Valier barley, respectively, P < 0.05), indicating the chemical matrix of micro-endosperm tissue are different. Harrington barley had a wider range of starch to protein ratio (1.41 to 10.12 vs. 1.42 to 4.27, P < 0.05), suggesting that Harrington barley is more heterogeneous than Varlier barley in chemical makeup of endosperm. In conclusion, different chemical makeup in micro-endosperm matrix may explain the biological difference. Lower starch to protein ratio in micro-endosperm tissue of Valier barley implicates that starch granules in Valier barley have more proteins associated with. This may prevent Valier barley degrade fast and highly in the rumen. More research is needed on plant chemical makeup of intrinsic mciro-structure for a better understanding of

plant inherent micro-structure in relation to biodegradation behaviors in animals

Key Words: Synchrotron infrared microspectroscopy, Chemical micromatrix of barley endosperm tissue, Ultra-structure

T128 Improved method for measuring processing degree and gelatinized starch in steam-flaked grain. Marcus Meilahn[1] and Davy Brown*[2], [1]*Weld Laboratories,* [2]*Agland, Inc.*.

The nutritive value of flaked grain can be quantified by measuring starch availability, degree of processing, and the percentage of gelatinized starch in relation to the total amount and availability of starch in whole (unprocessed) grain. A new, commercially available, enzymatic method is described for measuring the degree of processing and starch gelatinization in grain. The method utilizes the differences in reaction rates between corn starch and gelatinized corn starch. This method was used to determine the relationship between glucose yield and geletinized starch percent of known reference standards, whole grain, and flaked grain samples. The sensitivity for measuring degree of processing and gelatinized starch percent in flake grain was significantly improved (P<.001)over that by other methods currently used in the feeding industry. These data have been used to provide valuable information for grain processors to adjust milling practices resulting in improved flaked grain quality.

Key Words: Steam-flake, starch gelatinization, degree of processing

T129 Comparative effect of pork meat meal and chicken meat meal on apparent digestibility of diets for sheep. A. Estrada*[1], R. Barajas[1], and J. F. Obregon[1], [1]*FMVZ-Universidad Autónoma de Sinaloa (México).*

To determinate the comparative effect of pork meat meal and chicken meat meal on apparent digestibility of diets for sheep, a digestibility experiment by total fecal collection was conducted. Four Pelibuey sheep, males (BW=18.75 kg) were used in a cross over design experiment. The animals were placed individually in metabolics crates (0.6 x 1.2 m), and randomly were assigned to consume one of two diets in that consists the treatments: 1) Diet 15.8% of CP and 3.16 Mcal of DE/kg, containing (DM basis), pork meat meal 5.84%, ground corn 50.73%, sesame meal 10.22%, sudan grass hay 19.45%, sugarcane molasses 11.1%, urea 0.72%, limestone 1.1%, and mineral premix 0.89% (PMM); and 2) diet similar to treatment 1, but containing 5.84% of chicken meat meal (CHM) substituting all the pork meat meal. Diets were offered twice a day (800 and 1600 h), after six day of adaptation period, samples of diets (1 kg) and the total of feces produced were collected during four continuous days. samples were dried, weighed. DM and CP analyses were performed, and apparent digestibility was calculate. DM fecal excretion was not affected (P=0.23) by treatments (177 vs. 165 g/day). DM digestibility was similar (P=0.26) across treatments (73.5 vs. 75.2%). the fecal excretion of crude protein was similar (P=0.41) between treatments (34.0 vs. 35.6 g/day). The apparent digestibility of crude protein was not affected (P=0.62) by the kind of meat meal included, with values of 68.4% and 69.2% for pork and chicken meat meal, respectively. Calculate digestible energy of diets was equal (P=0.26) in both treatments (3.137 vs. 3.213 Mcal/kg). It is concluded that both pork meat meal and chicken meat meal could be indistinct used as rumen undegradable crude protein source, in growing sheep diets without affecting its digestion characteristics.

Key Words: Pork meat meal, Chicken meat meal, Digestibility

T130 Effects of intranasal administration of a lysozyme/zinc/carbopol preparation on health and performance of newly received beef cattle. J. D. Rivera*[1], J. T. Richeson[1], J. F. Gleghorn[1], N. A. Elam[1], M. L. Galyean[1], M. E. Hubbert[2], and S. E. Bachman[2], [1]*Texas Tech University, Lubbock, TX,* [2]*Ganado Research, Amarillo, TX.*

Ninety-one crossbred (British x Continental) steer and bull (17.5%) calves (average BW = 231± 17.5 kg) were used in a randomized complete block design to examine the effects of intranasal administration of a lysozyme/zinc/carbopol preparation on health and performance of lightweight newly received cattle. Calves were assigned randomly to pens, and each pair of pens (block) was assigned randomly to one of two treatments at receiving: intranasal (1 mL/nostril) of 1) lysozyme/zinc/carbopol solution (LYS); or 2) intranasal glycerol and water solution (CON). The lysozyme/zinc/carbopol solution was composed of 2.5 g of lysozyme, 2 g of zinc acetate, 1.25 g of carbopol 940, and 75 mL of glycerin brought to 100 mL volume with deionized water. Cattle were allowed ad libitum consumption of a 65% concentrate receiving diet along with long-stem alfalfa hay. Hay was fed for the first 5 d, after which only the 65% concentrate diet was offered. Cattle were monitored daily for signs of bovine respiratory disease (BRD) and treated with antibiotics as needed based on rectal temperature ($\geq 39.7^{(o)}$C). Body weight was measured on d 14 and 28 to determine ADG, and DMI was measured for the same time intervals as ADG. Intranasal administration of LYS did not affect (P > 0.10) ADG for d 0 to 14, 14 to 28, or 0 to 28. In addition, LYS administration did not affect feed:gain at any period of the study; however, administration of LYS tended to decrease (P < 0.08) DMI from d 0 to 14 and from d 0 to 28 (P < 0.11). Moreover, a trend (P < 0.12) for increased morbidity from BRD was observed for cattle receiving intranasal LYS. When analyzed by day after arrival, LYS increased morbidity (P < 0.03) on d 5 following receiving compared with CON. Results suggest that administration of LYS intranasally at receiving tended to increase morbidity later in the receiving period and decrease DMI, possibly because intranasal lysozyme might have increased the potential for later re-inoculation of the nasopharynx by respiratory pathogens.

Key Words: Lysozyme, Beef cattle, Health

T131 Effect of N-source on in vitro microbial crude protein and glycogen yields and NDF digestion from NDF and sucrose fermentations. L. Holtshausen* and M. B. Hall, *Department of Animal Sciences, University of Florida, Gainesville, FL USA.*

The effect of N-source on microbial crude protein yield (MCP), microbial glycogen yield (GLY), and NDF digestion was examined in two 16 h batch culture fermentations of isolated bermudagrass NDF (iNDF) or 50% sucrose+50% iNDF (SuNDF)(240 mg substrate/tube) with mixed ruminal microbes in 50 ml tubes fitted with gas release valves. The isonitrogenous media used were Goering and Van Soest medium (GVM), [non-protein nitrogen (NPN)+true protein; B], and GVM modified to contain only NPN (U) by substituting urea for casein acid hydrolysate, or to contain only true protein (C) by substituting casein acid hydrolysate+sodium bicarbonate for ammonium bicarbonate. Fermentation tubes for each substrate and medium were destructively sampled every 4 hours and analyzed for MCP, GLY and residual NDF. MCP was estimated as CP precipitated with 20% trichloroacetic acid, and GLY as alpha-glucan corrected for free glucose. MCP and GLY at each hour were corrected for 0 h and sampling hour fermentation blanks. All values presented are least squares means data at 16 h unless indicated. Orthogonal contrasts U vs B+C and B vs C were used for media comparisons (see table). By 8 h, no free sucrose, glucose or fructose remained. Maximum GLY was achieved at 4 h and MCP at 16 h. Media pH did not decline below 6.45. For all media, MCP was lower for iNDF than for SuNDF (P<0.01). For SuNDF MCP differed among media (P<0.01). At 4 h GLY did not differ across media for SuNDF (P=0.64). Medium affected NDF digestion for SuNDF (P<0.01) but not for iNDF (P=0.18). Gross efficiency of MCP per unit sucrose differed by medium (P<0.01). Adding true protein increased MCP from NDF, as well as increased fiber digestion, MCP, and efficiency of MCP when sucrose was present.

Item	B-iNDF	C-iNDF	U-iNDF	B-SuNDF	C-SuNDF	U-SuNDF
16 h MCP, mg^{a,x,y}	3.61	3.50	1.77	14.28	15.70	8.05
16 h MCP/Suc, mg^{x,y}	-	-	-	0.119	0.131	0.067
16 h NDF dig., %^{x}	18.5	16.0	16.6	21.0	19.5	14.4
4 h GLY, mg	-	-	-	7.31	7.17	6.84

Contrast superscripts: SuNDF: x = U vs B+C, y = B vs C, differ P<0.05; iNDF: a = U vs B+C, b = B vs C, differ P<0.05

Key Words: Sucrose, Nitrogen source, Fermentation

T132 Biohydrogenation of unsaturated fatty acids and duodenal flow of CLA and *trans*-fatty acids in dairy cows fed a high-concentrate diet supplemented with linseed, sunflower, or fish oil. J. J. Loor*[1,2], K. Ueda[1], A. Ferlay[1], Y. Chilliard[1], and M. Doreau[1], [1]*INRA, 63122 St.-Genes Champanelle, France,* [2]*Department of Animal Sciences, University of Illinois.*

Ruminal hydrogenation and duodenal flow of hydrogenation intermediates were evaluated in three lactating Holstein cows fed a diet with a high concentrate:forage ratio (65:35) plus 5% (DM basis) sunflower oil (SO), 5% linseed oil (LO), or 2.5% fish oil (FO). A 3 × 3 Latin square with 4-wk periods was used. Grass hay was the forage. Hydrogenation of *cis*9-18:1 (76%) did not differ ($P > 0.05$)due to oils. Dietary SO increased ($P < 0.05$) hydrogenation of 18:2*n*-6 (91%) compared with FO or LO (79%). Cows fed LO had greater ($P < 0.05$) 18:3*n*-3 hydrogenation (94%) compared with FO or SO (84%). Hydrogenation of eicosapentaenoic (EPA) and docosahexaenoic (DHA) acid due to feeding FO averaged 94% and 92%. Total CLA flow was greater ($P < 0.05$) in cows fed SO (8.0 g/d) compared with FO (4.0 g/d). Feeding LO resulted in flow of 6.9 g total CLA/d. Among CLA isomers, flow of *cis*9,*trans*11-CLA (9-11CLA) was ($P = 0.10$) 2.4 g/d with SO but only 0.4 g/d with FO. Dietary LO resulted in 1.6 g 9-11CLA/d. *Trans*10,*cis*12-CLA flow was not affected ($P > 0.05$) by diets and averaged 0.67 g/d. *Cis*9,*cis*11-CLA and *trans*11,*trans*13-CLA flow (1.0, 2.0 g/d) was greater ($P < 0.05$) in response to LO compared with FO or SO (0.3, 0.7 g/d). *Trans*,*trans*-CLA was greater ($P < 0.05$) when feeding SO (2.2 g/d) than FO or LO (1.2 g/d). Flow of *trans*11,*cis*15-18:2, derived from 18:3*n*-3 hydrogenation, ranked by treatment was ($P < 0.05$) LO (47 g/d) > FO (18 g/d) or SO (7.6 g/d). Total *trans*-18:1 flow did not differ due to oils (254 g/d). *Trans*10-18:1 flow was numerically greater ($P > 0.05$) in cows fed FO or SO (88 g/d) than LO (28 g/d). *Trans*11-18:1 flow averaged ($P > 0.05$) 89 g/d for FO or SO and 119 g/d for LO. Flow of 18:0 was ∼4× greater ($P < 0.05$) in cows fed SO or LO (373 g/d) than FO (96 g/d). Data suggest, hydrogenation of 18:2*n*-6, 18:3*n*-3, EPA, and DHA was largely a function of amount consumed. Supplemental 18:2*n*-6 and 18:3*n*-3 resulted in production of specific CLA isomers in the rumen.

Key Words: Biohydrogenation, *Trans* fatty acids, Oil

T133 Conjugated linoleic acids (CLA) and *trans*-fatty acid profiles of blood plasma and milk fat in dairy cows fed a high-concentrate diet supplemented with linseed, sunflower, or fish oil. J. J. Loor*[1,2], A. Ferlay[1], A. Ollier[1], K. Ueda[1], M. Doreau[1], and Y. Chilliard[1], [1]*INRA, 63122 St.-Genes Champanelle, France,* [2]*Department of Animal Sciences, University of Illinois.*

Profiles of hydrogenation intermediates in plasma and milk lipids due to dietary 18:2*n*-6, 18:3*n*-3, or 20:5*n*-3 were evaluated using three lactating Holstein cows fed a high-concentrate diet (65:35 concentrate to forage) with 5% (DM basis) sunflower oil (SO), 5% linseed oil (LO), or 2.5% fish oil (FO). A 3 × 3 Latin square with 4-wk periods was used with grass hay as the forage. Milk yield (26 kg/d), DMI (18 kg/d), and percentages of milk fat (2.64) and protein (3.22) did not differ ($P > 0.05$). Total plasma fatty acids averaged ($P > 0.05$) 2.8 mg/mL across diets. Percentage of *cis*9,*trans*11- (9/11CLA), *trans*10,*cis*12- (10/12CLA), *cis*9,*cis*11- (*c*9*c*11CLA), and *trans*11,*trans*13-18:2 (11/13CLA) in blood plasma also was similar ($P > 0.05$) (0.32, 0.09, 0.01, and 0.12%, respectively). *Trans*,*trans*-18:2 (*tt*CLA), however, was greater ($P < 0.05$) due to feeding FO (0.48%) compared with LO or SO (0.24%). Percentage of *trans*11,*cis*15-18:2 (11/15LA), an intermediate of 18:3*n*-3 hydrogenation, was greater ($P < 0.05$) when LO (0.87%) was fed, intermediate with FO (0.47%), and lower ($P < 0.05$) with SO (0.15%). Plasma *trans*10-18:1 was not altered ($P > 0.05$) by diets (0.90%). Plasma *trans*11-18:1 (TVA) was greater ($P < 0.05$) when FO (4.1%) was fed compared with LO or SO (2.3%). Percentage of 9/11CLA (2.2%), 10/12CLA (0.07%), *c*9*c*11CLA (0.07%), 11/13CLA (0.10%), and *tt*CLA (0.11%) in milk fat did not differ ($P > 0.05$). Milk 11/15LA ranked by treatment was ($P < 0.05$) LO (2.9%) > FO (1.8%) > SO (0.4%). Milk *trans*10-18:1 (4.8%) and TVA (5.4%) percentage was not altered ($P > 0.05$) by diets. Stearic acid in plasma or milk fat due to FO (8.4%, 3.5%) was reduced ($P < 0.05$) compared with LO or SO (14%, 11%). Except for TVA and *tt*CLA, results show that responses in the profile of other CLA, 11/15LA, and *trans*10-18:1 in blood plasma and milk fat followed the same trend due to feeding each oil.

Key Words: Oil, CLA, *Trans* fatty acids

T134 Effect of chromium methionine supplementation in diet on milk production of holstein pure breed and 3/4 holstein cows receiving recombinant bovine somatotropin in hormone injection. R. Barajas*[1], R. Zambada[1], J. J. Portillo[1], L. M. Rubio[1], C. Lizarraga[2], Z. Verdugo[1], and N. Gonzalez[1], [1]*FMVZ-Universidad Autonoma de Sinaloa (Mexico),* [2]*Establo Lechero.*

Whith the objective of determinate the effect of chromium methionine supplementation in diet on milk production of holstein pure breed and 3/4 holstein cows receiving recombinant bovine somatotropin hormone injection, a milk production experiment was conducted. Eighteen dairy cows (8 holstein pure breed cows, and 10 holstein 3/4 brahman 1/4 blood cows), pregnant, body size condition upper than 3.5, and producing upper than 17 kg of milk/day, were used in a complete randomized block design experiment. The cows were placed in a ground flour pen, providing an area of 48 m2/cow, shade area of 7.5 m2/cow, 3.1 m of feed bunker/cow and 0.5 m of drinker/cow. the animals were fed with a ration consistent in sudan grass silage 40 kg, alfalfa hay 2 kg, and 11 kg of pellet concentrate (18%CP, 7%CF, 4%fat, and 0.7% Ca) and has free access to a mineral premix. After a 14 days adjustment period, daily milk production (DMP) by cow was recorded during seven days, and was considered as previous milk production. Next days all the cows receiving an intradermal injection of bovine somatotropin hormone (STB), and agreement with its blood, and previous DMP were grouped and assigned to treatments: 1) Regular management as was described above (control); and 2) similar to control but receiving a supplementation of 12 mg of Cr/cow/day from chromium methionine during 14 days. Milk production was measured during 14 days. Data was analyzed as a factorial arrangement (Cr x day) of treatments and previous daily milk production has not effect (P=0.29) as covariate variable. STB increased (P<0.01) in 22.6% milk production (19.74 vs. 24.2 kg). In holstein pure breed cows STB improved (P<0.01) DMP (22.10 vs. 26.76 kg) in the same proportion (21%) than in 3/4 holstein cow (17.85 vs. 21.63 kg). Chromium methionine supplementation increased (P=0.02) DMP in 2.5% with relationship of cows that not received it (23.9 vs. 24.5 kg). It is concluded, that chromium methionine could help to improve milk production in dairy cows receiving bovine somatotropin hormone.

Key Words: Chromium, Somatotropin, Dairy cows

T135 Comparison of inorganic and complexed trace element supplements on performance of dairy cows. R. L. Kincaid*[1], J. D. Cronrath[1], and M. T. Socha[2], [1]*Washington State University,* [2]*Zinpro Corporation.*

To determine the effect of chemical form of trace element supplements on performance of dairy cows, Holstein cows (n = 36) were assigned to dietary treatments of inorganic trace elements and a combination (1:1) of inorganic and complexed trace elements. Starting 21 days prepartum, dry cows were fed hay and 1 of 2 grain supplements that contained the trace element supplements. Estimated concentrations of trace elements in the dry cows diets were 12 ppm Cu, 52 ppm Mn, 68 ppm Zn, and 1.8 ppm Co. From parturition until 150 DIM, cows were fed their respective TMR that contained 11 ppm Cu, 41 ppm Mn, 59 ppm Zn, and 2.5 ppm Co, by analysis. Cows fed the complexed trace elements lost less (P < 0.05) weight prepartum (23 vs 55 kg); however, there was no difference (P > 0.05) between treatments in postpartum weight change or BCS. Cows fed complexed trace elements prepartum had colostrum with higher (P < 0.05) IgG (5.1 vs 7.6 g/dl) and lower Zn (125 vs 91 ppm). There was no difference (P > 0.05) in concentrations of IgM, Co, Mn or Cu in colostrum. Dry matter intakes of lactating cows were similar between treatments (26.0 vs 26.4 kg/d). Although there were period effects on serum concentrations of IgG, IgM, NEFA, Zn, and Ca, there were no treatment effects. Actual milk yield (42.2 vs 41.7 kg/d), 3.5 FCM (42.3 vs 42.3 kg/d), and measures of production efficiency also were similar between treatments. These results indicate similar performance of cows fed inorganic and a mixture of inorganic and complexed trace elements.

Key Words: Cows, Inorganic trace elements, Complexed trace elements

T136 Effects of Lactonin on milk production of dairy cow during weeks 20 through 42 of lactation. Z. M. Shen*[1], R. F. Zhang[1], F. Chen[2], and T. S. Lu[3], [1]*Nanjing Agricultural University, Nanjing, China,* [2]*Shanghai Bright Group, China,* [3]*Shanghai Walcom Bio-Chem Co., Ltd , China.*

Lactonin is a compound containing 30% of cysteamine (CS). CS is a special component of coenzyme A and therefore an endogenous substance. One of the physiological functions of CS is to decline somatostatine but increase the blood glucose level. The purpose of this study was, therefore, to investigate the effects of Lactonin on milk production during weeks 20 through 42 of lactation. 100 black and white dairy cows were assigned to 4 groups (G1, n=21; G2 and G3, n=24 and G4, n=31) on the basis of their daily milk yield prior to the experiment and their calving date. The recorded daily milk yield (M) prior to the experiment is: G1<29 kg; G2,30-34 kg; G3,35-39 kg and G4>40 kg, respectively. In each group the cows were divided randomly into Lactonin treatment (LT) and Control. In all LT the Lactonin was administered progressively within 10 weeks period at the CS doses of 10-30 mg/d and then degressively to 15 mg/d through the experiment. In G1 cows received LT produced 17.8 % more milk (P<0.05) than did Control cows during the entire 23 weeks of treatment. But it was not in the cows received LT in the other groups, suggesting that the effect of LT on milk production was influenced by the starting basic milk yield of the cow in the pretreatment period. Milk fat percentage was greater for cows given LT both in G2 (5.8 %, P<0.05) and G4 (10.8 %, P<0.05) than that of Control cows. In G2 and G4 a trendy of increase (P=0.10) of milk protein percentage was observed in the cows treated with LT. In G4 The milk protein synthesis was 11.0 % higher (P<0.05) with cows given LT, resulting from the greater milk protein percentage induced by Lactonin. This study indicates that Lactonin can improve the milk yield and milk composition. The effects of Lactonin on milk production are related to the production level of cows prior to the treatment.

Key Words: Cysteamine, Cow, Milk production

T137 Serum β carotene concentrations and variability factors in US dairy herds. T. H. Herdt[1] and W. M. Seymour*[2], [1]*Michigan State University,* [2]*Roche Vitamins Inc.*

To determine descriptive statistics and selected variability factors for serum β carotene concentrations in US dairy cows, selected samples from the 1996 NAHMS Dairy study (Reference of 1996 Dairy Management Practices, USDA) were analyzed for β carotene, retinol, and cholesterol concentrations. A total of 358 serum samples distributed among 35 herds were tested by HPLC with UV detection. Samples were analyzed in 2001 and had been held at –80 C for approximately 80% of the storage time, and at –20 C for the remainder. Samples were selected to create a balanced data set with respect to herd size classification, region of the US, and use of pasture as a major forage (+/-). The overall mean of serum beta-carotene was 2.02 μg/ml with SD 1.94 μg/ml. The distribution of values was markedly skewed to the right, but approximated normal after log transformation. Serum β carotene was correlated positively (P<0.02), but weakly (R^2 =0.06) with serum retinol. In univariate analysis, samples from the Midwest had values lower than the Northeast, West, and Southeast, and samples from herds using pasture feeding had values higher than those not using pasture. Whether or not the cows from which the samples were taken were receiving pasture at the time of sampling was not known. A multivariate descriptive model of serum β carotene variation was constructed using PROC MIXED (SAS). Initial independent variables included herd, region, pasture, and pasture by region interaction. Serum cholesterol concentration was included as a covariate. Independent variables remaining in the model were herd (P<0.001), serum cholesterol (P<0.001), and pasture (P=0.08). Herd accounted for 68% of the total variability in serum β carotene. We conclude that serum β carotene concentrations in US dairy cattle are affected by herd management conditions, probably those associated with nutrition. Furthermore, many US dairy cows have serum β carotene concentrations less than 2.5 μg/ml, a target minimum concentration suggested by other investigators.

Key Words: β Carotene, Vitamin A, Retinol

T138 Phosphorus balance in dairy cows fed sub-optimal dietary phosphorus. K. V. Shore*, T Mutsvangwa, T. M. Widowski, J. P. Cant, W. J. Bettger, and B. W. McBride, *University of Guelph, Guelph, Ontario, Canada.*

Overfeeding phosphorus (P) in dairy rations is common practice with the average diet balanced to 0.48% P, approximately 30% more than recommended by NRC. The objective of this experiment was to determine if P homeostasis could be maintained at sub-optimal levels of P intake. This was established through P balance at two dietary levels of P, one at the recommended NRC level of 0.36% (n=7) and one at 0.24% (n=7), which has been previously shown to deplete cows of P. P balance was measured one week before the dry period, at 1 month prepartum and at 2 weeks postpartum to establish P balance on a corn silage, haylage based TMR. Once on the experimental diet (3 weeks to 13 weeks postpartum), P balance was measured at 6 weeks and 13 weeks postpartum. The experimental diet consisted of corn silage, urea, soybean meal, soybean hulls, beet pulp, bloodmeal, limestone, dicalcium phosphorus, salt, magnesium oxide, tallow and a mineral mix balanced to 0.36% P or 0.24% P. Results to date show there was no significant difference (p>0.05) in milk yield (31.3 $\pm$ 4.8 kg/day - 0.36% P; 31.6 $\pm$ 4.8 kg/day - 0.24% P) or dry matter intake (15.5 $\pm$ 0.9 kg/day - 0.36% P; 15.3 $\pm$ 0.9 kg/day - 0.24% P). Furthermore, there was no significant difference (p>0.05) in blood plasma calcium (2.48 $\pm$ 0.03mM - 0.36% P; 2.53 $\pm$ 0.03mM - 0.24% P), magnesium (1.02 $\pm$ 0.02mM - 0.36% P; 1.04 $\pm$ 0.02mM - 0.24% P) or P (1.84 $\pm$ 0.07mM - 0.36% P; 1.76 $\pm$ 0.07mM - 0.24% P), and all parameters remained within normal physiological range.

Key Words: Phosphorus, Dairy cattle, Balance

T139 Effects of supplemental conjugated linoleic acid and *trans*-octadecenoic fatty acids on the insulin-like growth factor system in periparturient Holstein cows. K. T. Selberg, A. C. Dinges, C. R. Staples, and L. Badinga*, *University of Florida, Gainesville.*

Thirty-eight multiparous Holstein cows were utilized in a completely randomized design to examine the effect of feeding ruminally-protected conjugated linoleic acid (CLA) and *trans*-octadecenoic fatty acids (tFA) on the insulin-like growth factor (IGF) system during the transition to lactation. Dietary treatments were initiated approximately 28 d prior to expected calving dates and continued through d 49 postpartum. Prepartum treatments consisted of 1) a basal TMR diet (control), 2) basal TMR + 231 g/d CLA mix (CLA), and 3) basal TMR + 214 g/d tFA mix. Average intakes of CLA and tFA mixes were 258 and 261 g/d, respectively, during the 49 d postpartum treatment period. On d 2, 14, and 28 $\pm$ 2 postpartum, liver samples were collected by biopsy and stored at -80^{o}C until analyzed for mRNA abundance. Plasma IGF-I concentration decreased (P<0.01) from 120.3 $\pm$ 5.5 ng/ml at 2 wk before parturition to 91.4 $\pm$ 5.4 ng/ml at calving, and remained low through 7 wk of lactation. In spite of small tendencies, IGF-I concentration in blood did not differ among dietary treatments. Plasma IGF-binding protein (IGFBP) profiles (MW = 44-48, 35, 31, 30, and 28 kDa) were unaffected by dietary treatment and sampling day. Liver IGF-I mRNA transcripts were low during the first few weeks of lactation and did not differ among treatments. The 7.5 kb IGF-I transcript was not detected until d 28 postpartum. Dietary supplementation of tFA upregulated steady-state levels of IGF-II and IGFBP-2 genes in the liver. The abundance of IGFBP-3 mRNA in the liver did not vary among dietary treatments. Results provide the first direct evidence that dietary tFAs induce hepatic IGF-II and IGFBP-2 genes in cattle. Additional studies are warranted to elucidate the interactions between supplemental fats, energy homeostasis and the IGF system in Holstein cows during the early lactation period.

Key Words: Fatty acids, IGF system, Cattle

T140 Effects of feeding calcium salts of fatty acids with methionine hydroxy analog and bacterial fermentation residue vs. tallow-vegetable blend and plant proteins on lactational performance and in-vitro fermentation. K. A. Koudele*[1], W. K. Sanchez[2], L. H. Adams[1], D. E. Weber[2], D. R. Metzger[3], N. R. St-Pierre[4], and E. Block[2], [1]*Andrews University, Berrien Springs, MI,* [2]*Arm & Hammer Nutrition Group, Church & Dwight Co, Inc., Princeton, NJ,* [3]*Metzger Cousulting Services, Goshen, IN,* [4]*Ohio State University, Columbus, OH.*

One hundred fifty-five free-stall housed multiparous Holstein cows from a high producing herd (RHA = 12,190 kg) were randomized by DIM (14-165 d) and milk production into two equally managed groups. Each group was fed either a control (CON) ration containing tallow-vegetable blend and plant proteins or a treatment (TMT) ration containing calcium salts of fatty acids complexed with methionine hydroxy analog (MEGALAC Plus®), and bacterial fermentation residue (FERMENTEN®) in a switch back design with five-28 d periods. Cows were fed ad lib daily with refused feed weighed weekly. Data from the last week of each period were used in the analysis. Diets were formulated to be similar in NDF, NFC and fat. Groups were the experimental units in the statistical analyses. Milk yield (43.5 vs. 43.2 kg), protein (2.79 vs. 2.76 %), lactose (4.79 vs. 4.79 %), SCC (313,000 vs. 310,000), and DMI (25.8 vs. 25.5) did not differ (P>0.05) between CON and TMT, respectively. However, milk fat % was higher (P=0.03) in the TMT group (3.99 vs. 3.75%). The TMR of CON and TMT rations were evaluated in triplicate 9-day continous culture fermenters which resulted in no differences (P>0.05) between CON and treatment in VFA production, acetate:propionate ratio and pH. Crude protein efficiency (% degraded feed N as microbial N) was greater (P=0.002) in the TMT group (84.73 vs. 88.19) due in part to the greater (P=0.03) ammonia-N production for CON (8.83 vs. 6.41 mg/dl). These differences were likely due to how the fat and proteins affected rumen fermentation and biohydrogenation. The higher milk fat % from cows on the TMT diet indicated that the combination of MEGALAC Plus® and FERMENTEN® were utilized more efficiently in the rumen than the tallow-vegetable blended fat and plant proteins.

Key Words: Dairy nutrition, Calcium salts of fatty acids, Bacterial fermentation residue

T141 Effects of saturation ratio of supplemental dietary fat on production performance of lactating Holstein cows in early lactation. M. A. Ballou*, E. J. DePeters, H. Perez-Monti, S. J. Taylor, and J. W. Pareas, *University of California, Davis.*

Lactating Holstein cows (n=47) were randomly assigned to one of four treatments to evaluate the effect of supplemental fat (tallow or yellow grease) from sources varying in proportion of unsaturated and saturated fatty acids on lactation performance. All diets (45% chopped alfalfa hay and 55% concentrates) contained 12% whole cottonseed (as-fed) and were fed as a TMR. Treatments were no supplemental fat (Control, 3% total fatty acids, DM basis) or the addition of 2% supplemental fat from Tallow, Yellow Grease, or Blend (60% tallow: 40% yellow grease). Unsaturated to saturated fatty acid ratios were 1:1 for tallow, 2.5:1 for yellow grease, and 1.5:1 for the blended fat. All cows were fed the control diet during week 3 of lactation. Cows were then assigned to their treatment diets beginning week 4 and ending week 18 of lactation. Cows were milked twice daily and yields recorded. Cows were fed their assigned TMR twice daily. Milk samples were collected once weekly and analyzed for fat, protein, solids-not-fat, and nitrogen fractions. Body condition scores (BCS) and body weights (BW) were assessed once weekly. Repeated measures were analyzed by the PROC MIXED procedure of SAS using week 3 as a covariate. There were no significant differences for intake of DM (25.6, 25.9, 25.6, and 26.4 kg/d) and yield of milk (41.8, 42.3, 42.3, and 43.6 kg/d) for the Control, Blend, Tallow, and Yellow Grease, respectively. Digestible energy intakes (DM basis) tended to increase when yellow grease was supplemented as compared to tallow. BCS and BW were similar across all treatments. Concentrations and yields of milk components were unaffected by fat supplementation or saturation level. Supplementing the diet of lactating cows with fat during early lactation did not affect production performance, and there were no effects due to the differences in the unsaturated to saturated fatty acid composition of the supplemental fat source.

Key Words: Dairy cows, Fat saturation, Fatty acids

T142 Techniques to measure the bioavailability of rumen-protected methionine supplements. C. E. Moore*[1], B. Sloan[2], D. A. Henderson[1], and L. H. Baumgard[1], [1]*University of Arizona, Tucson, AZ,* [2]*Adisseo, Alpharetta, GA.*

Methionine bioavailability was assessed in two ways: 1) blood plasma methionine concentrations and 2) impact on milk composition. Two different rumen-protected methionine supplements were evaluated using 72 Holsteins (H) and 48 Brown Swiss (BS) 40 to 200 DIM at trial initiation. Animals were pre-blocked based on breed and parity (primiparous vs. multiparous). Cows were then randomly assigned to a control diet (C: 48% alfalfa hay and 14.9% steam flaked corn; Alimet® was included [21.8 g/hd/d] to maximize microbial protein synthesis) formulated to be adequate in metabolizable lysine (6.83% of MP - CPM Version 1), or C supplemented with either Smartamine™ M (S; 16 g/hd/d), or Mepron® M85 (M; 14.1 g/hd/d), both supplements provided 12 g methionine/hd/d. Milk yield was recorded daily and milk samples were obtained on 2 consecutive milkings from each cow on d -1, 14, 28, 42 and 56 relative to treatment initiation for compositional analysis. Blood plasma samples were obtained on d 56 from 10 cows/trt and analyzed for amino acid content. There was no effect of treatment (P = 0.07) on milk yield (35.3 kg/d). Milk fat percentage was affected by treatment 3.80^a, 3.85^{ab} and 3.98^b for C, M and S, respectively. Milk protein % was increased by methionine treatments 3.11^a, 3.16^b and 3.20^b for C, M and S, respectively and milk lactose content and yield were reduced (2 and 4%) by both methionine supplements. Plasma concentrations (mg/ml) of methionine (P < 0.01) and methionine as a percentage of total amino acids (P < 0.01) were both significantly higher for S (3.43^a, 4.11^b, 5.20^c and 1.13^a, 1.27^b, 1.62^c for C, M and S, respectively). Both methionine supplements increased milk protein content and S increased milk fat compared to C and this illustrates the benefits of providing supplementary bio-available methionine to a ration adequate in metabolizable lysine. Furthermore, blood plasma methionine proved to be the more precise technique to discriminate between the relative methionine bioavailability of different rumen protected technologies.

Key Words: Methionine, Milk protein, Lactation

T143 Comparison of abomasal infusion of free fatty acid and methyl ester forms of conjugated linoleic acids on milk fat depression in dairy cows. M. J. de Veth*[1], J. M. Griinari[2], A. M. Pfeiffer[3], and D. E. Bauman[1], [1]*Cornell University, Ithaca, NY,* [2]*Clanet Ltd, Espoo, Finland,* [3]*BASF-AG, Offenbach, Germany.*

Conjugated linoleic acids (CLA), specifically the *trans*-10, *cis*-12 isomer, have been shown to be potent inhibitors of milk fat synthesis. The majority of studies investigating CLA-induced milk fat depression have used mixtures of CLA in free fatty acid form. However, in the commercial synthesis of CLA, methyl esters of CLA are initially formed. The objective of this study was to compare effects of the free fatty acid CLA (FFA-CLA) and methyl esters of CLA (ME-CLA) on the inhibition of milk fat synthesis. Three mid-lactation Holstein cows fitted with a rumen fistula were used in a 3 × 3 Latin square design. Treatments were 1) control, 2) FFA-CLA, and 3) ME-CLA. Treatments 2 & 3 involved a 60% CLA formulation that was composed equally of *trans*-10, *cis*-12 and *cis*-9, *trans*-11 isomers; the CLA formulation was solubilized in ethanol and a daily dose of 4.2 g of *trans*-10, *cis*-12 CLA was infused abomasally as equal aliquots at 6 h intervals. Each treatment period was 5 d with a 7 d interval between periods. CLA treatments reduced milk fat yield (P < 0.02) compared to control (0.77 kg/d), but there were no differences (P > 0.92) between FFA-CLA and ME-CLA (39% and 38% reduction, respectively). Milk yield, yield and content of milk protein, and DMI were unaltered (P > 0.14) by CLA treatment. Both *de novo* synthesis and the uptake of preformed fatty acids were affected as yields of all fatty acids (P < 0.08) were reduced by CLA treatment. However, there were no differences in the yield or proportions of individual fatty acids between the FFA-CLA and ME-CLA. Milk fatty acid content of *trans*-10, *cis*-12 CLA increased (P = 0.01) from < 0.01% in control to 0.18% and 0.17% for FFA-CLA and ME-CLA, respectively. The transfer efficiency of the abomasally infused *trans*-10, *cis*-12 CLA into milk fat averaged 18.8% for FFA-CLA and 17.8% for ME-CLA. Overall, results demonstrate that the ME-CLA are equally potent at reducing milk fat synthesis as the FFA-CLA, and that the presence of the methyl ester had no apparent effect on intestinal absorption of CLA or its incorporation into milk fat. Therefore, rumen-protected forms that utilize either free

fatty acids or methyl esters of *trans*-10, *cis*-12 CLA would be effective dietary supplements of CLA to induce milk fat depression.

Key Words: Conjugated linoleic acid, Milk fat depression, Milk fat

T144 *Trans*-fatty acids (*t*FA), CLA isomers, and milk fat depression (MFD) in dairy cows receiving incremental doses of fish oil. J. J. Loor*[1,3], J. M. Chardigny[2], J. Chabrot[1], M. Doreau[1], A. Ollier[1], J. L. Sebedio[2], and Y. Chilliard[1], [1]*INRA, 63122 St.-Genes Champanelle, France,* [2]*INRA, 21065 Dijon, France,* [3]*Department of Animal Sciences, University of Illinois.*

Correlations (CORR) between percentage of *t*FA in milk and milk fat percentage (MF%) due to fish oil (FO) were evaluated using data from two independent exp. (n = 45). Exp. were conducted as replicated 3 × 3 Latin squares with 4-wk periods using corn silage, and doses of 0, 200, 300, or 400 mL FO/d into the rumen. MF% was 3.52, 2.40, 2.51, or 2.17 due to incremental FO. Highest positive CORR were between 18:0 (0.68) or oleic acid (0.63), both of which were markedly reduced by FO, and MF%. All *t*-18:1 isomers, except *t*16-18:1, were negatively correlated with MF%. *T*9-18:1 (-0.69) and *t*12-18:1 (-0.68) had the most negative CORR. CORR for *t*10-18:1 and *t*11-18:1 (TVA) were -0.58 or -0.47. All CLA isomers, except *t*10,*c*12-CLA which was not detectable, were negatively correlated with MF%. *T*11,*t*13-18:2 had the most negative CORR (-0.55). *T*11,*c*15-18:2, derived from 18:3*n*-3 hydrogenation, had a CORR of -0.62 with MF%. Among individual isomers, *t*4- to *t*13+14-18:1 were all negatively correlated with 6:0, 8:0, or 10:0 concentration. *T*10-18:1, however, had the most negative CORR with 8:0, 10:0, 12:0, and 14:0 (0.33-0.55). Although CORR between *t*-18:1 isomers and 16:0 was not significant (-0.16), that between *tt*-CLA and 16:0 was -0.59. Concentration of EPA, DPA, and DHA also were negatively correlated (-0.55) with 16:0, but not with MF% (-0.16). *T*4- to *t*9-18:1 and *t*12- to *t*13+14-18:1 had CORR of 0.67 to 0.80 with TVA, and -0.14 to 0.59 with *t*10-18:1. TVA had CORR of 0.15 with *t*10-18:1. CORR between TVA and *c*9,*t*11-CLA was 0.94. Data suggest other *t*-18:1 are more closely associated with MFD than *t*10-18:1 or *t*10,*c*12-CLA in cows fed FO. Certain rumen-derived *t*-18:1 and CLA isomers may interact to reduce *de novo* FA synthesis. Lower endogenous synthesis of *c*9-18:1, due to reduced 18:0 availability, may be an additional factor leading to decreased MF% and fat yield in cows fed FO.

Key Words: Fish oil, CLA, *Trans* fatty acids

T145 *Trans* fatty acids (*t*FA) and CLA in liquid-associated (LAB) and solid-adherent (SAB) ruminal bacteria from dairy cows fed diets varying in forage:concentrate ratio (F:C) and level of linseed, sunflower, or fish oil. J. J. Loor*[1,2], K. Ueda[1], A. Ferlay[1], Y. Chilliard[1], and M. Doreau[1], [1]*INRA, 63122 St.-Genes Champanelle, France,* [2]*Department of Animal Sciences, University of Illinois.*

CLA and *t*FA percentage in LAB and SAB due to F:C and unsaturated oils was evaluated. Exp. periods lasted 4-wk with grass hay as the forage. In exp. 1, four Holstein cows were fed a diet with low (35:65) or high (65:35) F:C without (LC, HC) or with linseed oil at 3% of DM (LCL3, HCL3) in a 4 × 4 Latin square. In exp. 2, three Holstein cows were fed HC with 5% linseed (HCL5), 5% sunflower (HCS5), or 2.5% fish oil (HCF2.5) in a 3 × 3 Latin square. LAB and SAB contained 65-95 mg total FA/g DM with LC and HC, or 65-168 mg/g with oils. *C*9,*t*11-CLA (9/11CLA) was 0.3% in SAB and 0.1% in LAB with LC or HC, and increased little with LCL3 or HCL3. Feeding HCF2.5 increased 9/11CLA (1.0% vs 0.6%) in SAB compared with HCL5 or HCS5. In LAB, 9/11CLA averaged 0.6% across diets. *T*10,*c*12-CLA (10/12CLA) in SAB was greater when LC or HCL3 (0.1%) were fed compared with LCL3 or HC (0.05%). No differences in 10/12CLA were found in LAB (0.1%). Oils did not alter 10/12CLA in SAB (0.2%) or LAB (0.2%) in exp. 2. *C*9,*c*11- (*c*9*c*11CLA) and *t*11,*t*13-CLA (11/13CLA) in SAB or LAB increased with LCL3 or HCL3. Feeding HCL5 also increased *c*9*c*11CLA and 11/13CLA but only in SAB. *T*11,*c*15-18:2, an intermediate of 18:3*n*-3 hydrogenation, was markedly higher in SAB or LAB in response to LCL3, HCL3, and HCL5 but also increased with HCF2.5. *T*10-18:1 was 4.5% in LAB or SAB when HC or HCL3 were fed compared with LC or LCL3 (0.7%). Feeding HCS5 or HCF2.5 increased *t*10-18:1 in SAB or LAB compared with HCL5 (6.8% vs 2.1%). *T*11-18:1 (TVA) averaged 12% in SAB and LAB from cows fed HCL3 compared with 4.1% for LC, LCL3, or HC. Oils did not alter TVA (11%) in SAB or LAB in exp. 2. Low F:C alone nearly maximized *t*10-18:1, but not TVA or CLA*n*s. Profiles of FA in bacterial and duodenal lipids were similar. PUFA composition of oils, regardless of F:C, distinctively alters CLA and *t*FA in ruminal bacteria.

Key Words: CLA, Ruminal bacteria, *trans* fatty acids

T146 Effects of free methionine and lysine on performance and ruminal fermentation of late lactation Holstein cows. Y. H Chung*, H. G. Bateman, C. C. Williams, C. C. Stanely, P. A. Terrell, and D. T. Gantt, *LSU AgCenter, Baton Rouge, LA.*

Sixteen Holstein cows in late lactation (mean DIM = 207) were paired by current milk production and DIM and randomly assigned to one of two diets. Diets were based on corn silage with alfalfa hay. Concentrates for diets included ground corn and a commercial protein mixture. Diets differed by addition of 0.29% methionine and 2.9% lysine (DM basis). Methionine was provided as dl-methionine and lysine was provided as lysine-HCl. Cows were fed individually and intake measured daily for 28 d. Milk was measured and sampled at each milking. Samples of rumen fluid were collected via stomach tube at the beginning, midpoint, and end of the trial. Adding amino acids did not alter mean DMI, OM intake ($P > 0.15$), milk yield ($P > 0.7$), or milk production efficiency (kg milk / kg DMI; $P > 0.6$). Supplemental amino acids also had no effect on milk component percentages or production ($P > 0.5$). There was a statistical interaction of treatment and day on study for DMI, OM intake ($P< 0.01$), and milk production efficiency ($P < 0.05$) but the biological implications of these interactions are nonsignificant. As expected, supplemental amino acids increased ruminal NH_3 concentrations ($P < 0.01$). Supplemental amino acids decreased ($P < 0.01$) the proportion of acetate and increased ($P < 0.01$) the proportion of butyrate without affecting the proportions of any other VFA ($P > 0.2$) or total VFA concentrations ($P> 0.6$). These data indicate that free methionine and lysine alter ruminal fermentation but this change may not be large enough to elicit a production response in late lactation cows.

Key Words: Methionine, Lysine, Milk production

T147 Transfer of dietary fatty acids and hydrogenation intermediates from duodenum to milk in cows fed diets varying in forage:concentrate ratio and level of linseed, sunflower, or fish oil. . J. J. Loor*[1,2], K. Ueda[1], A. Ferlay[1], M. Doreau[1], and Y. Chilliard[1], [1]*INRA, 63122 St.-Genes Champanelle, France,* [2]*Department of Animal Sciences, University of Illinois.*

Relationships between duodenal flow and milk secretion of fatty acids due to dietary forage:concentrate ratio (F:C) and unsaturated oil were evaluated using data from two exp. Exp. periods were of 4-wk with grass hay as the forage. In exp. 1, four Holstein cows were fed a diet with low (35:65) or high (65:35) F:C without (LC, HC) or with linseed oil at 3% of DM (LCL3, HCL3) in a 4 × 4 Latin square. In exp. 2, three Holstein cows were fed HC with 5% linseed (HCL5), 5% sunflower (HCS5), or 2.5% fish oil (HCF2.5) in a 3 × 3 Latin square. Mean transfer of 18:2*n*-6 from duodenum to milk was 48% in cows fed LC compared with 41% for HC. Feeding LCL3 increased 18:2*n*-6 transfer (59%) compared with HCL3 (28%). In exp. 2, no differences due to diet were observed (37%). Dietary 18:3*n*-3 transfer averaged 60% or 53% in cows fed LC or HC. Feeding LCL3 compared with HCL3 increased 18:3*n*-3 transfer. Transfer of 18:3*n*-3 in exp. 2 was greater in cows fed HCF2.5 (42%) compared with HCL5 (29%). In exp 2., transfer of 20:5*n*-3, 22:5*n*-3, and 22:6*n*-3 in cows fed HCF2.5 averaged 39, 52, and 22%, respectively. *Trans*10-18:1 transfer was greater in cows fed LC than HC (72% vs 51%), but decreased in response to LCL3 or HCL3. In exp 2., *trans*10-18:1 transfer was 43%. Transfer of *trans*11-18:1+*cis*9,*trans*11-CLA (TVA+CLA) was 59% or 50% due to LC or HC, and feeding LCL3 increased it compared with HCL3 (63% vs 26%). In exp. 2, HCF2.5 increased TVA+CLA transfer markedly compared with HCL5 or HCS5 (66% vs 40%). There was a positive correlation (r = 0.66) between duodenal flow of TVA+CLA and their yield in milk, and between duodenal TVA flow and milk CLA yield (r = 0.74). Results indicate transfer rate for dietary fatty acids and biohydrogenation intermediates from duodenum to milk differs with forage:concentrate ratio and oil type.

Key Words: Forage:concentrate ratio, Oil, Milk fat

T148 Effect of level of dietary crude protein on milk yield and ruminal metabolism in lactating dairy cows. J. J. Olmos Colmenero*[1] and G. A. Broderick[2], [1]*University of Wisconsin-Madison,* [2]*U.S. Dairy Forage Research Center.*

Optimizing dietary CP is important for improving N efficiency in dairy production. Forty lactating Holstein cows (10 ruminally fistulated) were used in an incomplete 5 x 5 Latin Square design with 4-wk periods to assess the effects of different dietary CP levels on milk yield and ruminal metabolism. Diets contained (% of DM) 25% alfalfa silage, 25% corn silage, and 50% concentrate. High moisture corn was replaced with solvent soybean meal to increase CP from 14.6% (diet A), to 15.6% (diet B), 16.6% (diet C), 17.1% (diet D), and 18.4% (diet E). DMI and milk and lactose yield followed the same pattern, with response on diet C being greater than that on diets A and D. Yield of FCM and protein had a similar pattern except that diet C was only greater than diet A. Milk/DMI, fat yield, and ruminal propionate and total VFA did not differ. As expected, MUN and ruminal ammonia increased linearly with dietary CP content. Digestibility of DM and NDF was higher on diets B and C than on diets A, D, and E and significant quadratic effects were noted for both traits. Overall, poorer N utilization was associated with diets higher in CP. A diet containing 16.6% CP was adequate to sustain production under the conditions of this study.

	CP, % of DM						Prob.	
Item	14.6	15.6	16.6	17.1	18.4	SE[1]	Linear	Quad.
DMI, kg/d	21.6^{b}	21.8^{ab}	22.5^{a}	21.6^{b}	21.7^{ab}	0.4	0.91	0.12
Milk Yield, kg/d	36.3^{b}	37.2^{ab}	38.3^{a}	36.6^{b}	36.7^{ab}	0.9	0.60	0.11
3.5 % FCM, kg/d	34.1^{b}	35.6^{ab}	36.7^{a}	35.7^{ab}	36.1^{ab}	1.1	0.09	0.17
Milk/DMI	1.71	1.71	1.72	1.70	1.72	0.04	0.87	0.99
Fat yield, kg/d	1.14	1.20	1.24	1.23	1.24	0.06	0.06	0.30
Protein yield, kg/d	1.10^{b}	1.15^{ab}	1.18^{a}	1.13^{ab}	1.15^{ab}	0.03	0.21	0.10
Lactose yield, kg/d	1.78^{b}	1.81^{ab}	1.91^{a}	1.78^{b}	1.82^{ab}	0.06	0.58	0.18
MUN, mg/dl	7.71^{d}	8.50^{d}	11.2^{c}	13.0^{b}	15.6^{a}	0.6	< 0.01	0.13
DM digestibility, %	71.2^{c}	74.6^{a}	74.0^{a}	72.5^{b}	72.3^{bc}	0.6	0.79	< 0.01
NDF digestibility, %	45.8^{d}	51.2^{a}	49.5^{a}	48.0^{bc}	48.7^{bc}	1.0	0.18	< 0.01
Ruminal metabolites								
Total VFA, mM	78.0	83.0	84.7	84.1	84.3	4.8	0.17	0.34
Acetate, mM	45.1^{b}	48.4^{ab}	49.0^{ab}	49.9^{ab}	50.9^{a}	2.9	0.03	0.56
Propionate, mM	18.5	20.1	20.9	19.0	18.5	1.3	0.76	0.06
Ac:Pr	2.63^{c}	2.57^{cd}	2.48^{d}	2.77^{b}	2.91^{a}	0.07	< 0.01	< 0.01
Ammonia, mM	4.34^{c}	5.49^{b}	6.54^{b}	9.08^{a}	9.14^{a}	0.54	< 0.01	0.34

^{a,b,c,d}Means in rows with no common superscripts are different ($P < 0.05$). [1]SE = Standard error of the difference of the least square means.

Key Words: Dietary protein, Milk yield, N-efficiency

T149 Feeding calcium salts of linoleic and linolenic essential fatty acids to pre and post-partum Holstein cows improves reproduction, health and profit. W. K. Sanchez*, E. Block, and K. R. Cummings, *ARM & HAMMER Animal Nutrition Group, Church & Dwight Co, Inc., Princeton, N.J..*

Field trials involving over 5,000 high producing Holstein cows (averaging > 12,300 kg ME milk) with over 14,000 eligible breedings were conducted to evaluate the effects of feeding calcium salts of essential fatty acids (linoleic and linolenic acids as MEGALAC-R®; MEG-R) on reproduction, health, and lactational performance. Cows were fed either a control close-up, fresh cow, and high group ration; CON) or a similar set of treatment rations plus MEG-R (115 g for 21-d before calving, 227 g for 10-21 d postpartum, and 454 g through 110 d postpartum) in place of tallow or MEGALAC®). In two trials MEGALAC was the control and in two trials tallow was the control. The percentages of pregnancies and health events were compared using a standard chi-square analysis. Overall cumulative pregnancy rates were 6.5% greater ($P < 0.05$) for animals fed MEG-R. Primiparous cows responded better (>10% response) to MEG-R than multiparous cows, but the multiparous cows fed the larger dose (454 g) of MEG-R had the greatest response (19% increase overall). Health events were recorded in three trials and milk fevers, displaced abomasums, cases of mastitis, and abortions were all lower ($P < 0.10$) for cows fed MEG-R. Milk production and milk composition was similar ($P > 0.05$) between groups, likely due to the fact that the control and treatment diets were similar in calories. Effects of reproduction and health changes on milk yield, culling patterns and herd composition (i.e. the number of calves, heifers, and cows) were used to estimate the economic impact. With \$10/cwt milk, \$500 culls, \$250 calves, and \$1500 replacements the net return from feeding MEG-R was \$19 per cow overall (a 90% return on investment). The herd fed 454 g MEG-R netted \$45 per cow (a 250% return on investment). This research indicates that feeding calcium salts of linoleic and linolenic essential fatty acids can improve reproduction, health and profitability on commercial dairy farms.

Key Words: Dairy nutrition, Reproduction, Health

T150 Effect of dietary soybean oil on lactation performance and conjugated linoleic acid (CLA) concentration in milk of cows on commercial dairy farms. N. Plourde*, J. P. Faucher, J. Delisle, D. Pellerin, and P.Y. Chouinard, *Universite Laval.*

The CLA content of milk from cows in usually low. However, this proportion can be enhanced by dietary addition of soybean oil (SO), which is rich in linoleic acid. Our objective was to evaluate the effect of dietary SO on milk production, milk composition and CLA concentrations in milk from cows under commercial conditions. In this multi-site trial, 254 cows from 12 different farms were used. For the first 7 farms, the herd was divided into two groups. The first group remained on the normal herd diet and the second group received SO at the rate of 1 l/d. For the other 5 farms, the herd was divided into two groups according to lactation stage (early vs. late). Within each of these groups half of the cows remained on the herd diet. The second half received SO at the rate of 1 l/d for cows in early lactation, and 0.5 l/d for cows in late lactation. Soybean oil was added to the diets at the expense of grain concentrates on an energy basis. Metabolizable protein supply was maintained by adjusting the concentration of rumen-undegradable protein. Vitamin E was added in SO at the rate of 1000 IU/l. Experimental period was 8-wk in length. Milk production was recorded and milk was sampled every week for chemical analysis. Milk yield and milk protein yield were not affected by treatments. Milk protein content tended to decrease ($P<0.06$) for cows receiving 1 l/d of SO (-3.0%). Milk fat content decreased (-6.3% and -18.7%; $P<0.05$) for cows fed 0.5 and 1 l/d of SO, respectively. Milk fat yield decreased (-22.2%; $P<0.05$) only for cows receiving 1 l/d of SO. Dietary addition of SO increased ($P<0.05$) milk fat content of CLA from 5.2 to 20.0 and 18.8 mg/g of fatty acids for cows fed 0.5 and 1 l/d of SO, respectively. Soybean oil can be used on commercial dairies to produce high CLA milk fat.

Key Words: soybean oil, conjugated linoleic acid, milk fat

T151 Effects of essential oils and monensin on ruminal pH, ammonia concentration and in situ degradation of dry matter and nitrogen in the rumen of lactating dairy cows. C. Benchaar*[1,2], T. D. Whyte[2], H. V. Petit[1], R. Berthiaume[1], D. R. Ouellet[1], and P. Y. Chouinard[3], [1]*Agriculture and Agri-Food Canada, Lennoxville, Quebec, Canada,* [2]*Nova Scotia Agricultural College, Truro, Nova Scotia, Canada,* [3]*Universite Laval, Ste-Foy, QC, Canada.*

ABSTRACT Four ruminally cannulated lactating cows were used in a 4x4 Latin square design to examine the effects of dietary addition of essential oils (Crina®) and monensin (Rumensin®) on in situ ruminal degradability of soybean meal, ruminal pH and ammonia concentration in the rumen fluid. Cows were fed for ad libitum intake a TMR unsupplemented (control, CO), or supplemented with essentials oils (2 g/d, EO), monensin (350 mg/d, MO) or a combination of both additives (EO+MO). Each experimental period consisted of two weeks of adjustment to the diet, three days for in situ incubation, and two days for rumen fluid sampling. No interaction was observed ($P>.05$) between EO and MO. The rapidly (a), and the slowly degradable fractions (b) of DM were not affected ($P>0.05$) by additive treatments (36.9 and 62.8%, respectively). However, DM degradation rate tended to be higher (7.1 vs 6.4%/h; $P=0.08$) and effective degradability (ED) was increased (67.5 vs 65.9%; $P<0.05$) for cows fed MO. Fractions (a) and (b), and degradation rate of OM were not changed ($P>0.05$) by treatments. ED of OM was slightly higher (66.7 vs 64.9%; $P<0.05$) for cows fed MO. Degradation kinetics of CP showed that the fraction (a) was lower ($P<0.05$) with MO. Inversely, this fraction was increased ($P=0.05$) when cows were fed EO. Fraction (b) was not changed by dietary treatments (83.9%; $P>0.05$).

CP degradation rate was slightly higher (6.0 vs 5.5%/h; $P<0.05$) with MO and tended to increase (5.9 vs 5.6%/h; $P=0.07$) for cows fed EO. Effective CP degradability increased (55.6 vs 53.0%; $P<0.05$) with MO. Ruminal pH was increased (+ 0.11 points; $P=0$ .04) or tended to increase (+ 0.09 points; $P=0.08$) with the addition of EO and MO, respectively. Ammonia concentration in the rumen fluid was reduced (12.7 vs 14.3 mg/100 ml; $P<0.05$) for cows fed MO. This study showed that the addition of EO and MO in dairy cow diets has minor effects on protein degradation and ammonia concentration in the rumen. More investigation is needed to assess the effectiveness of essential oils to impact protein digestion and rumen fermentation.

Key Words: Essential oils, Monensin, Protein degradation

T152 Effect of vitamin E supplementation in late lactation on milk production and milk fatty acid profile. J. K. Kay, L. H. Baumgard, E. S. Kolver, and J. R. Roche, [1]*Dexcel (formerly Dairying Research Corporation), Hamilton, New Zealand,* [2]*University of Arizona, Tucson, Arizona.*

High dietary concentrations of vitamin E (Vit. E) have been shown to prevent milk fat depression in lactating dairy cows. Pasture-fed cows have higher milk fat concentrations than cows on TMR and it was hypothesised that the higher concentration of Vit. E in pasture (107 ± 38 iu/kg), compared with TMR (26 ± 3 iu/kg), may contribute to the higher milk fat concentration, possibly through lower *trans*-10, *cis*-12 conjugated linoleic acid (CLA) concentration in milk fat. Eighteen Holstein-Friesian cows in late lactation receiving either ad libitum pasture (n=6) or a TMR of corn silage, grass silage and concentrates, were used. The 12 TMR cows received either the recommended (NORM) dietary Vit. E concentration (23 iu/kg DM; n=6) or an additional 10,000 iu/cow/d of supplemental Vit. E (HIGH; n=6) for 21 d. AM and PM milk samples were collected on d 20 and 21. Pasture cows produced milk with higher ($P < 0.1$) milk fat concentration and produced more *cis*-9, *trans*-11 CLA and *trans*-11 18:1 (TVA), and less *trans*-10 18:1 per 100g total milk fatty acids than cows fed TMR. HIGH cows produced milk with a higher ($P < 0.05$) fat concentration than NORM cows, but fat yield was not affected. Although concentrations of TVA were higher ($P < 0.1$) in the plasma of HIGH cows and there was a trend ($P < 0.14$) for a reduced concentration of *trans*-10 18:1, there was no difference in the concentration of these fatty acids in milk. *Trans*-10, *cis*-12 CLA concentrations were not detectable in milk or plasma. Further research is required to investigate the role of Vit E. in milk fat synthesis.

Key Words: Pasture, Vitamin E, Milk fat depression

T153 Partial replacement of corn grain with calcium salts of fatty acid in the concentrate fed to grazing primiparous and multiparous dairy cows. G. F. Schroeder*[1,2], G. A. Gagliostro[3], L. I. Vidaurreta[1], J. J. Couderc[1,2], P. Gatti[4], A. Rodriguez[4], and G. Eyherarbide[1], [1]*Fac. Cs. Agrarias. UNMdP,* [2]*CONICET,* [3]*INTA EEA Balcarce,* [4]*INTI CITIL PTM, Argentina.*

Thirty-two multiparous (**MC**, 580 kg BW) and 18 primiparous (**PC**, 497 kg BW) Holsteins cows grazing an alfalfa pasture were used in a factorial design to study the effects of parity and calcium salts of unsaturated fatty acids (**CSFA**) supplementation on DMI, milk production and composition, and milk fatty acids (**FA**) profile. The dietary treatments consisted in two isoenergetic concentrates composed by 7 kg/d of ground corn grain and 0.4 kg/d of fish meal (**Control**) or 4.8 kg/d of corn grain, 0.4 kg/d of fish meal and 0.9 kg/d of CSFA (**Fat**). The FA composition of CSFA was: 16% C16:0, 13.5% C18:0, 32% C18:1, 30% C18:2. Neither pasture nor total DMI were affected by dietary treatment or parity. Milk yield was increased in PC receiving CSFA but no effects were observed on MC. Fat corrected milk, milk fat percentage and milk fat yield were decreased by CSFA supplementation on MC with no effects on PC. Milk protein percentage was increased in MC but decreased in PC by fat supplementation. No interaction between dietary treatment by parity was found for milk FA composition recorded at 60 DIM. The partial replacement of corn by CSFA in the concentrate resulted in a reduction in short- (7.8 vs 5.1 %) and medium-chain FA (38.7 vs 30.4 %) and an increase in C18:1 (21.4 vs 25.6 %), C18:2 (2.8 vs 8.9 %), and C18:3 (0.94 vs 1.24 %) contented. Fat supplementation increased milk CLA content in MC (1.82 vs 2.05 %) with no effects on PC. In conclusion, the effect of CSFA supplementation in grazing MC and PC on milk production and composition seemed to be different depending on the parity of the cows.

	Dietary treatment					P value		
	Control		Fat					
	MC	PC	MC	PC	SEM	Dietary	Parity	D x P
DMI, kg/d								
Concentrate	4.51	4.64	3.87	3.82	0.05	0.01	0.47	0.11
Pasture	13.7	15.0	15.3	13.1	0.91	0.92	0.64	0.09
Total	18.2	19.6	19.2	17.0	0.90	0.41	0.66	0.08
Milk, kg/d	26.6	20.4 b	25.0	22.2 a	0.47	0.93	0.01	0.02
4 % FCM, kg/d	24.5 a	18.9	21.2 b	19.9	0.98	0.14	0.01	0.01
Milk Fat, %	3.53	3.57	3.22	3.40	0.07	0.02	0.28	0.53
Milk Fat, kg/d	0.93 a	0.72	0.76 b	0.73	0.03	0.04	0.01	0.02
Milk Protein, %	3.19 b	3.20 a	3.30 a	3.09 b	0.03	0.90	0.03	0.02
Milk Protein, kg/d	0.85	0.65	0.81	0.68	0.02	0.96	0.01	0.13

a, b, c Least square means in the same row with different superscripts differ ($P < 0.05$).

Key Words: Fat supplementation, Parity, Grazing

T154 Biotin supplementation for periparturient dairy cows. O. Rosendo[1], C. R. Staples*[1], L. R. McDowell[1], R. J. McMahon[1], and W. M. Seymour[2], [1]*University of Florida, Gainesville, FL,* [2]*Roche Vitamins, Inc., Parsippany, NJ.*

Multiparous Holstein cows were fed an average of 0 or 20 mg/d of biotin from an average of 17 d prepartum to calving and 0 or 30 mg/d of biotin from calving to 70 d postpartum. Diets fed during the nonlactating period were 1.63 Mcal NEL/kg and 13.4% CP whereas diets fed during the lactating period were 1.69 Mcal NEL/kg and 17.3% CP (DM basis). Mean concentration of biotin in plasma sampled weekly was greater in cows fed biotin (9.4 vs. 4.3 nM/liter; S.E. = 0.5). Mean intake of DM was 8.6 and 10.3 kg/d (S.E. = 0.8) during the nonlactating period and 22.1 and 23.8 kg/d (S.E. = 0.7) postpartum for cows fed control (C; n = 18) and biotin (B; n = 20) diets, respectively. Intakes were not different. Production of milk (35.8 vs. 34.8 kg/d; S.E. = 1.3), milk fat concentration (3.59 vs. 3.69%; S.E. = 0.08), and milk protein concentration (2.73 vs. 2.83%; S.E. = 0.05) were similar between treatment groups. Concentrations of plasma NEFA were lower at weeks 2 (652 vs. 413 mEq/L) and 4 (381 vs. 196 mEq/L) postpartum whereas mean concentration of plasma glucose was greater for cows fed supplemental biotin (63.4 vs. 66.6 mg/dl; S.E. = 0.8). Mean concentration of plasma beta-hydroxybutyric acid (5.4 vs. 4.8 mg/dl; S.E = 0.3) and urea nitrogen (14.9 vs. 14.8; S.E = 0.4) were not affected by biotin supplementation. Biopsies of liver were taken at 2 d, 14 ± 2 d, and 28 ± 2 d postpartum. Total lipid concentration of liver (wet and dry basis) in control cows tended to increase at d 14 whereas that of cows fed biotin decreased (quadratic effect of day by diet interaction). Mean total lipid concentration was 6.8 vs. 6.3, 7.5 vs. 5.7, and 5.6 vs. 4.8% (wet basis) for control and biotin-supplemented cows on days 2, 14 and 28 respectively. Feeding supplemental biotin at 20 g/d during the last 17 d prepartum and at 30 g/d postpartum had a positive effect on metabolic status as evidenced by lowered blood NEFA, elevated blood glucose, and lowered liver lipid concentrations.

Key Words: Biotin, Lactation, Liver

T155 Effects of dietary addition of essential oils and monensin on nutrient digestibility, nitrogen retention, milk production and milk composition of Holstein cows. C. Benchaar*[1,2], T. D. Whyte[2], R. Berthiaume[1], H. V. Petit[1], D. R. Ouellet[1], and P. Y. Chouinard[3], [1]*Agriculture and Agri-Food Canada, Lennoxville, Quebec, Canada,* [2]*Nova Scotia Agricultural College, Truro, Nova Scotia, Canada,* [3]*Universite Laval, Ste-Foy, QC, Canada.*

Four lactating dairy cows were used in a 4 x 4 Latin square design to study the effects of dietary addition of essential oils (Crina®) and monensin (Rumensin®) on nutrient digestibility, nitrogen retention, milk production and milk composition. Cows were fed for ad libitum a TMR unsupplemented (control, CO), or supplemented with essentials oils (2 g/d, EO), monensin (350 mg/d, MO) or a combination of both additives (EO+MO). Each experimental period consisted of 21 days of adjustment

to the diet and 7 days for data recording and sample collection. No interaction ($P>0.05$) was observed between EO and MO. Dry matter intake was not affected by dietary additives (22.7 kg/d, $P>0.05$). Apparent DM (66.6%), OM (68.3%), and NDF (47.9%) digestibilities were similar ($P>0.05$) among treatments. However, apparent ADF digestibility was higher (48.9 vs. 46.0%; $P<0.05$) for cows fed EO. Apparent CP digestibility was increased (65.0 vs. 63.6%; $P=0.05$) when cows were fed MO. Nitrogen retention was not changed (27.1 g/d; $P>0.05$) by treatments. Production of milk and 4% FCM remained unchanged ($P>0.05$) among treatments (33.6 and 33.4 kg/d, respectively). Milk protein and lactose concentrations were not different ($P>0.05$) between treatments (3.5 and 4.6%, respectively). Milk fat and total solids contents were lower (3.8 vs. 4.1% and 12.6 vs. 13.0%; $P<0.05$) for cows fed MO. Milk urea-nitrogen concentration tended to increase (12.6 vs. 12.0 mg/dl; $P=0.06$) for cows fed MO. Somatic cell count was not affected by additive treatments ($55x10^3$/ml; $P>0.05$). Initial and final body weights were unaffected ($P>0.05$) by treatments. However, body weight change was higher (0.4 vs. 0.2 kg/d; $P=0.05$) for cows fed EO. This study showed that the addition of essential oils and monensin does not have major impacts on nutrient digestibility and milk production and composition in dairy cows. Further investigations are needed to evaluate the potential of adding essential oils in dairy cow diets to manipulate rumen fermentation and to improve feed efficiency.

Key Words: Essential oils, Monensin, Cows

T156 Relation of arterial concentration of lysine and methionine milk and milk protein production: a twenty-year literature review.

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This study investigated relationships of blood methionine and lysine concentration from literature studies to milk yield, protein yield and milk protein %. Data consisted of all studies published in the Journal of Dairy Science between 1982 and 2002 with sufficient information on dietary composition, dry matter intake, milk yield, milk protein percent and jugular concentrations of MET and LYS. Sixty-six studies met the established criteria, representing 281 diets at 21 institutions. Diets were entered into the Mepron Dairy Ration Evaluator (AMRE) to predict duodenal amino acid flow, MET and LYS as a percent of metabolizable protein and ratio of LYS:MET. Main effects of AA measurement (serum or plasma), cow breed and study type (protein fed or infused beyond the rumen) were assessed with PROC MIXED of SAS. Linear relationships between blood MET and LYS concentrations and dietary measures were assessed with PROC REG, while non-linear relationships were studied with PROC NLIN.

In these studies there was no significant difference in MET or LYS concentration whether measured in serum or plasma, so studies were pooled. Breed had a significant effect on milk protein %, but not on blood AA concentration. Linear regression was significant only for duodenal flow of MET on milk yield and milk protein yield (P<.05) overall. There was no significant relation to blood AA. Non-linearly, duodenal MET and LYS were significantly associated with milk yield, milk protein % and milk protein yield (P<.01). Duodenal MET, MET as % of MP or LYS:MET were not significantly related to blood MET. Duodenal LYS and LYS:MET, but not LYS as % MP, were related to blood LYS. Blood MET but not LYS was related to protein%. This study suggests that duodenal MET and LYS as well as MET and LYS as a percent of MP are associated with milk yield, protein % and protein yield in a non-linear manner. Blood AA is not consistently correlated, and its use as a measure of AA adequacy is questionable.

Key Words: Methionine, Lysine, Dairy cattle

T157 Response of pre-partum and early lactation dairy cows to dietary inclusion of ruminally inert conjugated linoleic acid.

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A study was conducted to determine the feed intake and milk production response of pre-partum and early lactation dairy cows to inclusion of partially rumen protected calcium salts of conjugated linoleic acid (CLA). Thirty-four multiparous cows during dry period were blocked according to calving date and milk yield from previous lactation. Within blocks cows were randomly assigned to control (CT) or CLA (CL) treatments. Cows in both treatments were fed a dry cow diet containing 84% forage 3 wk prior to due calving date, a fresh cow diet containing forage to grain in 51:49 ratio for 2 wk post-calving and a milking diet containing forage to grain in 47:53 ratio during weeks 3 to 10 of lactation. In addition to the basal diet, cows in CT and CL received 0 and 150 g of CLA supplement before calving and 225 g of hydrolyzed animal fat or 225 g of CLA supplement after calving, respectively. The fat supplements were top dressed on the total mixed ration. Daily feed intake and milk yield were recorded. Weekly milk samples from 6 consecutive milkings were analyzed for fat, protein and lactose content. Weekly composite milk samples collected from 6 consecutive milkings during 1, 2, 3, 4, 5 and 10 wk were analyzed for fatty acid profile. Cows in CT and CL treatments had similar DMI before calving. During 1-10 wk of lactation the average DMI was 23.0 and 20.8 kg/d (P <0.07), milk yield 46.0 and 45.0 kg/d, energy corrected milk 32.8 and 29.6 kg/d (P <0.03), fat content 3.90 and 3.45% (P <0.01), protein content 2.89 and 2.82%, fat yield 1.76 and 1.47 kg/d (P <0.01), protein yield 1.31 and 1.24 kg/d, lactose content 4.86 and 4.81%, and ECM/DMI 1.48 and 1.52 in CT and CL treatments, respectively. The average CLA content of milk was 3.8 and 3.5 mg/g of fat in CT and CL treatments, respectively. Results suggest that feeding partially rumen protected CLA supplement 3 wk prior to calving had no influence on feed intake. Feeding CLA supplement during early lactation reduced fat content, fat yield and energy corrected milk yield and had no influence on CLA content of milk fat. The CLA supplement can be used as a tool to reduce fat content of milk.

Key Words: Cow, Milk, Conjugated linoleic acid

T158 Comparison of commercially available rumen-stable choline products.

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The objectives were to determine the rumen DM and choline stability of five commercially available rumen-stable choline products and to determine qualitative differences of rumen-stable nutrients by measuring rumen DM and nutrient stability. Products evaluated were Reashure® (25% choline; Balchem Encapsulates, New Hampton, NY), product A (13% choline) product B (40% choline; Italian manufactured, North American distributed), product C (40% choline, Italian manufactured, Asian distributed), product D (25% choline; Canadian manufactured, North American distributed). Products were obtained through commercial distributors, and stored at ambient temperature. Dry matter and choline stability were determined at 0.5, 6, 12 and 24 hours of incubation using an Ankom Dairy II Incubator. Triplicate samples were used for each time point; corn silage was used as an internal standard. Each sample bag was dried for 24 hr at 65 C, with residues weighed and analyzed for choline content using a choline oxidase based detection system. Rumen-stability was calculated by subtracting the recovered DM or choline from the amount of DM or choline added to the bag originally. Results are detailed in the table below. All products had reasonable DM stability (63 to 98% at the 12 hr time point). However, choline stability varied considerably, with only one product (Reashure) having choline stability after 12 hr of incubation. In conclusion, considerable differences exist between commercially available rumen-stable choline products. Measuring DM stability is not an acceptable method for accessing the quality of rumen-stable nutrients.®

	Reashure		Product A		Product B		Product C		Product D	
	Mean	SD	Mean	SD	Mean	SD	Mean	SD	Mean	SD
Time(hr)	Rumen DM stability, %									
0.5	99.8	1.1	87.5	1.1	63.7	0.4	65.5	0.7	79.3	1.4
6	98.9	1.2	86.6	0.7	63.1	0.6	63.1	0.5	73.4	1.0
12	98.4	0.9	86.6	0.8	63.0	0.3	63.1	0.1	71.6	0.2
24	97.4	0.8	85.7	3.3	62.0	1.6	62.4	0.3	71.3	0.8
	Rumen choline stability, %									
0.5	82.3	3.7	3.0	1.8	0.4	0.4	7.2	3.6	21.9	1.5
6	77.8	3.3	1.3	1.6	0.0	0.0	0.0	0.0	3.5	1.2
12	75.6	1.1	0.8	1.0	0.0	0.0	0.0	0.0	1.6	0.1
24	70.4	3.7	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0

Key Words: Choline, Rumen, Stable

T159 A comparison of the 1989 and 2001 National Research Council models on predicting protein requirements for dairy cows. K. Guo* and R. Kohn, *University of Maryland.*

The objective of this study was to compare the accuracy and precision of predicting protein requirements for lactating dairy cows using the 1989 and 2001 NRC models. The study was based on two previously published research datasets. Both of the datasets were conducted with specifically formulated low crude protein (CP) diets with varied rumen degraded (RDP) and rumen undegraded protein (RUP) and a high CP diet as control. The first dataset varied RUP percentage at a constant CP content in early, mid and late lactation. Low RUP diets resulted in reduced milk production especially in early lactation (32 kg/d vs. 37 kg/d). The 1989 model predicted reduced milk production with the low RUP diet, especially in early lactation (30.1 kg/d vs. 34.6 kg/d), as observed. The 2001 model overestimated RUP supply, predicting adequate RUP even when production losses were observed from RUP deficiency. The 1989 model predicted sufficient N for bacterial synthesis for cows at all lactation stages fed both control and high RDP diets. The 2001 model predicted deficient rumen N for all diets and all stages. The second dataset included diets with different RDP concentrations but the same level of RUP. The low RDP diets resulted in reduced milk production (32.2 kg/d vs. 34.0 kg/d). Both 1989 model and 2001 model predict the reduced milk production (32.3kg/d vs. 34.5kg/d and 31kg/d vs. 38.8kg/d respectively). For both data sets, the 1989 model predicted protein allowable milk production was similar to the actual milk (P>0.05). The 2001 model underestimated allowable milk by 2.72kg/d for the first data set, and overestimated allowable milk by 2.5 kg/d for the second data set. With both datasets, 2001 model predicted significantly lower bacteria synthesized protein (p<0.001) and higher supply of RUP than the 1989 model.

Key Words: Protein requirement, RDP, Model evaluation

T160 Influence of HMBi concentration on in vitro estimated organic matter digestibility of diets varying in proportion of corn silage relative to concentrate. J. C. Robert*, S. Paquet, C. Richard, and B. Bouza, *Adisseo, Antony, France.*

HMBi is a novel source of methionine for ruminants : 50% is absorbed by the rumen wall to provide metabolisable methionine and the remaining 50% is hydrolysed in the rumen to HMB which stimulates rumen fermentation in vitro (Robert et al., 2002). Using the rumen simulation technique (HFT gas test-Menke et al., 1988), 4 doses of HMBi were tested in this study (mg/syringe : respectively : 0-3-6-9 Met. equivalent) with 5 combinations : corn silage (CS), concentrate (C), CS+C (%70-30)(CSC_1), CS+C(%50-50)(CSC_2), CS+C(%30-70)(CSC_3). The concentrate composition was (%) barley, 41 ; beetpulp, 37 ; soyabean meal, 15 ; urea, 2 ; molasses, 5. Main characteristics of corn silage were : %DM, 29.8 ; protein, 7.6 ; UFL/Kg DM : 0.88. 200 mg of dried and ground substrate was incubated with 10 ml of rumen juice + 20 ml of buffer in syringes gently agitated at 39°C. Gas production was measured after 24h. 2 replicates per serie and 6 series were completed. The prediction equations proposed by Menke et al(1988) were used to calculate organic matter digestibility (OMD %) and energy values (UFL/Kg DM). Significant increases of OMD were observed for all the combinations incubated with 6 or 9 mg of HMBi. The effects of HMBi on corn silage and the concentrate were additive.
From these results, the projected improvement (UFL/Kg DM) is estimated at 0.02 and 0.05 for the corn silage and concentrate respectively in the presence of HMBi. This corresponds to a 0.5 to 1.1 UFL/day increase in energy supply to a lactating dairy cow which theoritically corresponds to about 1 to 2 kg more milk.

Substrates	CS (σ)	C (σ)	CSC_1 (σ)	CSC_2(σ)	CSC_3(σ)
Control	72.6b(1.8)	88.5b(1.3)	75.9b(1.4)	80.2b(1.6)	82.7b(1.2)
HMBi (9 mg)					
measured	74.2a(1.9)	91.4a(1.4)	78.2a($_1$)(1.3)	82.2a($_1$)(1.1)	85.3a($_1$)(0.9)
calculated*	-	-	79.2($_1$)(1.5)	82.7($_1$)(1.5)	86.2($_1$)(1.4)

values with the same letter and figure (1) in column are not significantly different p<0.05.
*calculated taking into account values measured in CS and C and proportions in mixed rations.

Key Words: HMBi, Lactating dairy cows, Digestibility

T161 Milk production and composition and prostaglandin secretion in dairy cows fed different fat sources. H. V. Petit*[1], C. Germiquet[2], and D. Lebel[2], [1]*Agriculture and Agri-Food Canada, Dairy and Swine Research and Development Centre,* [2]*Département de Biologie, Université de Sherbrooke.*

Four non-lactating multiparous Holstein cows were used in a 4 X 4 Latin square design experiment to study the effects of feeding different fat sources on milk production and composition and prostaglandin secretion. All cows were fed a total mixed diet containing around 50% silage and 50% concentrate. All diets were equal in protein and energy contents. Four different concentrates were tested: Megalac®, whole linseed, whole sunflower seed, and absence of fat in the concentrate. Estrous cycles were synchronized for each period and animals were challenged with oxytocin (100 IU) to stimulate uterine PGF production. Mean concentrations of 13,14-dihydro-15-keto-PGF_{2alpha} in blood between 0 and 120 min following the oxytocin injection were lower ($P = 0.07$) for cows fed Megalac (55.1 pg/ml) and flaxseed (55.5 pg/ml) than for those fed whole sunflower seed (102.7 pg/ml); cows fed control had intermediate values (71.4 pg/ml). Mean plasma progesterone concentration was lower ($P < 0.05$) for cows fed flaxseed (6,430 pg/ml) compared to those fed control (10,108 pg/ml) or sunflower (9,061 pg/ml); cows fed Megalac had intermediate values (6,610 pg/ml). Feed intake averaged 21.7 kg/d and was similar ($P > 0.05$) among treatments. Milk yield was greater ($P < 0.05$) for cows fed Megalac (31.5 kg/d) and flaxseed (32.1 kg/d) compared to those fed sunflower seed (25.9 kg/d) and control (24.8 kg/d). Digestibilities of DM, CP, ADF, NDF, and energy were similar among treatments. Milk fat percentage was similar ($P > 0.05$) among treatments but milk protein concentration tended ($P = 0.11$) to be greater for cows fed flaxseed (3.87%) and control (3.92%) compared to those fed Megalac (3.68%); cows fed sunflower seed had intermediate values (3.74%). Feeding flaxseed decreased ($P < 0.05$) the omega 6 to omega 3 fatty acids ratio in milk (2.8) compared to feeding control (6.5), Megalac (6.8) and sunflower (9.9). In conclusion, feeding a source of omega 3 fatty acids such as flaxseed decreased secretion of the the dienoic prostaglandin PGF_{2alpha} compared to feeding a source of omega 6 fatty acids such as sunflower seed, which could contribute in improving gestation rate as observed in other studies.

Key Words: Dairy cattle, Fatty acids, Reproduction

T162 Effects of monensin and (or) high levels of zinc on ruminal degradation of free lysine and liquid hydroxy-methylthiobutanoic acid. H. G. Bateman, II*[1], C. C. Williams[1], D. T. Gantt[1], Y. H. Chung[1], A. E. Beem[1], C. C. Stanley[1], G. E. Goodier[1], P. G. Hoyt[2], and L. D. Bunting[3], [1]*LSU AgCenter, Baton Rouge, LA,* [2]*LSU School of Vet Medicine, Baton Rouge, LA,* [3]*Archer Daniels Midland Company, Quincy, IL.*

Four nonlactating Holstein cows were used in a Latin square designed experiment to investigate the effects of monensin (M) and high levels of Zn on ruminal degradation of lysine and hydroxy-methylthiobutanoic acid (HMB). Treatments were arranged as a 2 x 2 factorial of added ZnSO4 (0 or 500 ppm Zn) with or without M (0 or 40 ppm). Diets were based on alfalfa hay (50% of DM) with a grain supplement and were limit-fed at 8.2 kg of DM/cow daily. Lysine-HCl (85g) and HMB (50g) were dosed through the rumen cannula on the last day of each period and ruminal concentrations of each compound were measured every 0.5 h for 8 h. Neither added Zn nor M affected the fractional disappearance rates of lysine ($P > 0.2$) through 8 h. Stable rumen lysine concentrations were reached by 6 h post-dosing; when data prior to 6 h were analyzed, M tended ($P = 0.13$) to decrease the rate of disappearance of lysine. The disappearance rate of HMB tended ($P = 0.098$) to be decreased by M through 8 h. High levels of Zn increased ($P = 0.04$) the proportion of propionate in rumen fluid but had no effect on the proportion of acetate. As expected, M decreased ($P = 0.052$) the proportion of acetate and increased ($P = 0.02$) the proportion of propionate in rumen fluid. Neither M nor Zn affected ($P > 0.19$) total VFA in ruminal fluid. Dietary treatments had no effect ($P > 0.2$) on ruminal NH3 or peptides. Unexpectedly, supplemental Zn increased ($P = 0.02$) the rate of disappearance of soybean meal and tended ($P = 0.08$) to increase the rate of disappearance of extruded soybean meal from nylon bags. These data suggest that supplemental Zn and M alter ruminal fermentation patterns and M but not Zn may decrease the rate of ruminal degradation of lysine and HMB.

Key Words: Hydroxy-methylthiobutanoic acid, Amino acid, Degredation

T163 Influence of HMBi, HMB and combination of both on ruminal metabolism in vivo. J. C. Robert*, E. Madiot, C. Richard, and B. Bouza, *Adisseo, Antony, France*.

Four non lactacting, rumen cannulated, Holstein cows were randomly assigned in a latin square design (4×3 week periods) to four treatments (animal per day supplementation) : C = Control, H1 = 8g Rhodimet AT88 ^{TM} (Adisseo) ; H2 = 9.8g HMBi ; H3 = 4g Rhodimet AT88^{TM} + 9.8g HMBi. These quantities supplied respectively 7g methionine equivalent for H1 and H2 and 10.5g for H3. Estimated HMB available in the rumen was : 7g for H1 and H3 and 3.5g for H2 based on assumed availabilities in the rumen of 100% for pure HMB and 50% for pure HMBi. Ration fed was composed of (DMI per animal per day) = corn silage 4.2 kg + corn grain 1 kg + concentrate 2 kg (composition % barley, 41 ; beet pulp, 37 ; soybean meal, 15 ; molasses, 5 ; urea, 2). Ruminal juice was collected two days during the third week of each period at 8h30 and 10h30 for pH, ammonia-N and VFA measurements. Representative gas samples were collected through rumen canulae with a special device (Jouany et al., 1979)on two days during the third week of each period at 8h30 and 9h30 for CO2, CH4, H2S, CH3SH and DMS determinations. In general treatments H1 and H3 lowered concentrations of acetate (molar%)and increased concentrations of ammonia-N, butyrate (molar%), H2S and CH3SH compared to the Control and H2 treatment. It appears that the quantity of HMB ruminally available from the level of HMBi used in H2 was insufficient to modify ruminal metabolism except for propionate which was decreased with H2 but the mode of action is unclear and this result needs to be verified. For the higher levels of rumen available HMB (H1 and H3), the changes in individual VFA (molar%) : decrease in acetate, increase in butyrate -classic with HMB- could be due to changes in microbial population. Increases of ammonia-N, H2S and CH3SH can be assumed to be linked directly to dethiomethylation of HMB in the rumen and linked to the quantity of HMB degraded.

		C	H1	H2	H3	SED
Ruminal Juice						
VFA						
(molar%)	Acetate C2	68.3a	67.0b	68.1a	67.8a	0.84
	Propionate C3	15.6a	15.2a	14.4b	15.4a	0.69
	Butyrate C4	11.5c	13.1a	12.7ab	12.5b	0.56
	ratio C2/C3	4.39b	4.43b	4.76a	4.45b	0.244
Ammonia-N						
(mg%g)	N-NH3	26.0b	31.9a	28.9ab	29.1ab	4.37
Ruminal gas	(mg/L)					
	H2S	0.461b	0.613a	0.539a	0.582a	0.074
	CH3SH	0.012b	0.019a	0.013b	0.016a	0.004
HMB available in rumen (%DMI)		0	0.1	0.05	0.1	

a,b : values in the same line with the same letter are not significantly different : $p < 0.05$

Key Words: Amino acid, Ruminant, Nutrition

T164 Milk choline concentration as an index of bioavailability of rumen-protected choline. J. R. Newbold* and J. Lavrijssen, *Provimi Research and Technology Centre, Brussels, Belgium*.

Milk choline has been suggested as an index of bioavailability of rumen-protected choline (RPC). Our objective was to identify the response of milk choline concentration to RPC in order to define an appropriate feeding rate at which different sources of RPC may be compared. Eight primiparous Holstein cows (days in milk = 233, SE 14.3) were used in duplicate 4x4 Latin Squares with two-week periods. Treatments were: A, Negative control; B, Low-RPC (equivalent to 25g choline chloride/d); C, High-RPC (50g choline chloride/d) and D, Unprotected choline chloride (50g/d). RPC was a fat-encapsulated product (Provimi Italia, Agrate Brianza, Italy)containing 250g/kg choline chloride. Fractionated palm oil was used to equalise fat intake across treatments. A semi-complete ration based on maize silage, grass silage and a protein concentrate was offered ad libitum, supplemented with 1kg (Square 1) or 0.5kg (Square 2) of an additional concentrate. Milk choline was determined for four consecutive milkings at the end of each period by a modification of the method of Woollard and Indyk (2000, Journal of AOAC International 83:131).There were no effects (P>0.1)of treatment on dry matter, milk yield or milk fat or protein concentration. Mean choline concentrations (mg/l milk) were: A. 47.2; B. 53.7; C. 58.3; D. 54.1, SE=2.64, P=0.06). Milk choline concentration varied considerably between cows (38.0-69.5mg/l). There was a weak linear response of milk choline concentration to supplemental RPC (milk choline (mg/l) = 47.5 + 0.22 (g/d choline chloride as RPC), P=0.12, r2=0.12). With no evidence of a curvilinear response, a feeding rate of 50g/d may be appropriate for comparison of sources of RPC. However, large variation between cows suggests that replication should be increased if possibly subtle differences between RPC sources are to be identified. Exploratory linear regression showed a weak positive relationship between milk choline and dry matter intake (P=0.09). Lack of effects on milk production was not unexpected, given the advanced stage of lactation of cows in this experiment.

Key Words: Choline, Dairy, Cow

T165 Lactation performance of dairy cows fed different amounts of protein. E. B. Groff* and Z. Wu, *Pennsylvania State University*.

Excess N from agriculture has become a crucial experimental problem. Reducing protein allowances and altering the forage portion of the diet are tools considered to be effective in minimizing N excretion. Sixteen Holstein cows (80 ± 18 DIM) were utilized in a replicated 4 x 4 Latin square design to determine the effects of dietary protein concentration on lactation performance and N excretion. The experimental period included 2 wk for adaption followed by 1 wk for data collection. Diets had a 50 : 50 forage to concentrate ratio and were formulated to contain 15.00, 16.25, 17.50, or 18.75% CP. The forage portion of the diet consisted of 75% alfalfa silage and 25% corn silage. Increasing dietary CP did not (P >0.05) have an effect on milk yield, but resulted in a linear increase in MUN, PUN, fecal N and urinary N concentrations(P <0.05). Varying the conentration of protein from 15.00 to 18.75% in diets that used a 75 : 25 alfalfa to corn silage ratio did not effect overall lactation performance. Results are consistent with previous trials that used different alfalfa to corn silage ratios.

Dietary Protein (%)

Item	15.00	16.25	17.50	18.75	Effect	SEM
DMI (kg/d)	28.6	28.4	30.0	28.9	L	0.8
Milk (kg/d)	34.7	34.9	35.8	36.5	NS	1.4
MUN (mg/dl)	6.2	6.8	8.5	9.9	L	0.5
Milk fat (%)	3.46	3.55	3.54	3.63	NS	0.17
Milk protein (%)	3.06	3.01	3.04	3.03	NS	0.08
PUN (mg/dl)	7.8	8.4	10.1	12.3	L	0.5
Fecal N (%)	14.9	16.2	17.0	17.7	L	0.2
Urine N (g/L)	5.1	5.6	6.6	7.5	L	0.3

Significant at P <0.05 for C = cubic, L = linear effects, or NS = not signficant effects.

Key Words: Protein, Dairy cows, Forage

T166 Limiting amino acids of some tropical forages and their residues after rumen incubation, related to milk protein amino acidic composition. L. Miranda[1], N. Rodrigues[2], R. Sainz*[3], E. Pereira[4], M. Gontijo Netto[5], C. Veloso[6], and A. Queiroz[7], [1]*FEAD-Minas, Brazil,* [2]*Universidade Federal Minas Gerais, Brazil,* [3]*University of California- Davis, USA,* [4]*Universidade Estadual Oeste Parana,* [5]*EMBRAPA Gado de Corte, Brazil*.

A comparison between the amino acid profiles of feed protein and milk protein can help to assess the ideal amino acid supply required for milk protein synthesis. A comparative analysis of the profile of essential amino acids found in forages and their corresponding residues after 18 hours of rumen incubation, and the profile of milk protein (milk protein score, MPS) shows that: lysine, isoleucine and methionine were the first three limiting amino acids found in leucena, whereas for the corresponding residues the sequence was methionine, lysine and isoleucine. Lysine, isoleucine and leucine were the first three limiting amino acids found in perennial soybean; and methionine, leucine and lysine were the most significant ones in residues after 18 hours of rumen incubation. For cassava, the first three limiting amino acids were leucine, lysine and threonine, with leucine, arginine and histidine for the residue. Amino acid profiles were similar for pigeon pea and its residue after rumen incubation. Lysine, leucine and isoleucine were the limiting amino acids found for ramie, and arginine, lysine and phenylalanine were the limiting amino acids for the residue. MPS for ramie was the highest among forages, and remained the highest among residues of rumen incubation.

MPS for cassava was higher in the residue than in the original forage, but remained the lowest for all the forages studied. After rumen incubation, predominant limiting amino acids changed in all forages, except for pigeon pea, showing that the amino acid composition of the non-degradable fraction differs from the one found in the original forage.

Key Words: Limiting amino acids, Milk protein composition

T167 Changes in volatile fatty acid and *trans* fatty acid concentrations in the rumen of lactating Holstein cows fed four concentrations of unsaturated free fatty acids. S. A. Mosley, E. J. Thies, E. E. Mosley, and T. C. Jenkins*, *Clemson University, Clemson, SC 29634*.

The accumulation of unsaturated fatty acids in ruminal contents can disrupt both carbohydrate fermentation and lipid biohydrogenation increasing the passage of fiber and *trans* fatty acids to the intestines. Previous results suggested that these negative effects of unsaturated fatty acids are more related to their accumulation in the rumen as the free acid rather than in esterified lipid fractions. This study was conducted to determine the pattern and extent of changes in volatile fatty acid (VFA) and *trans* fatty acid concentrations that accompany increasing concentrations of unsaturated free fatty acids (UFFA) in the rumen. Four diets were fed to four lactating Holstein cows (fitted with a ruminal cannula) in a 4 x 4 Latin square design with 2-week periods. Diets contained 0, 1, 2, or 3% (DM basis) added unsaturated free fatty acids (UFFA) consisting of 61% linoleic acid, 29% oleic acid, and 5% linolenic acid. Samples were taken from the rumen just prior to the morning feeding, and at 0.5, 1, 1.5, or 2 hours after feeding on the last day of each period. As UFFA increased in the diet, the concentrations of UFFA in ruminal contents increased ($P < 0.01$) linearly (4.2, 5.8, 7.5, and 8.5 mg/g DM), dry matter intake declined ($P = 0.02$) linearly (from 25.5 to 22.2 kg/d), but milk yield did not change. Total VFA concentration ($P = 0.07$) and the ratio of acetate to propionate ($P < 0.01$) both declined linearly as UFFA increased in the diet. However, as UFFA increased from 0 to 3% of the diet DM, the *trans*-C18:1 concentrations in ruminal contents increased quadratically averaging 4.6, 5.4, 5.3, and 9.4% of total fatty acids ($P = 0.13$) and 1.2, 1.7, 1.9, and 4.0 mg/g DM ($P = 0.14$). Linear increases in UFFA concentration in ruminal contents were accompanied by quadratic increases in *trans*-C18:1/C18:2 (0.46, 0.54, 0.60, and 1.31, $P = 0.04$) and *trans*-C18:1/C18:0 (0.11, 0.12, 0.12, and 0.22, $P = 0.13$). This study shows that increases in ruminal UFFA concentration from feeding fat supplements will disrupt fermentation in direct proportion to its concentration. However, ruminal UFFA concentrations in excess of 7.5 mg/g DM were required to appreciably disrupt biohydrogenation and increase the concentration of *trans* monoenes.

Key Words: Rumen, Fatty Acids, Fermentation

T168 Milk protein response to rumen protected methionine in two commercial herds in central Mexico. H. Gutierrez*[1], G. Zavala[2], and R. A. Patton[3], [1]*Ganaderos Asociados de Queretaro, Queretaro, Mexico,* [2]*Degussa Mexico, Mexico City, Mexico,* [3]*Nittany Dairy Nutrition, Mifflinburg, PA*.

We wished to test whether a small amount of rumen protected methionine (RPMet) included in a total mixed ration and fed under commercial conditions could affect milk protein production. Rations were evaluated relative to the 2001 NRC suggested ratio of methionine and lysine as a percent of metabolizable protein, LYS:MET ratio and theoretical daily requirements for MET and LYS. Two dairy herds, feeding diets typical of the geographic area, feeding the same amount of protein supplement and having approximately the same ratio of LYS to MET in the diet were selected. RPMet (Mepron®) was fed at 11 g per day mixed into a protein supplement fed at 4.2 kg/head/day in a switchback design. Only cows finishing all six weeks of the study (n=613) were analyzed. Milk was weighed one day per week. Composite samples were submitted to a commercial laboratory for analysis of milk CP %, milk fat % and MUN (Alpura, Cuautitlan, Mexico). Statistical analysis was by the Mixed procedure of SAS with compound symmetry covariance. Fixed terms included RPAA and parity. Random factors were farm and period with time as repeated factor and cow (herd) as subject. AA sufficiency was analyzed using the Mepron Dairy Ration Evaluator (Ver 2.6). These data indicate small additions of RPMet can significantly increase milk protein production in a commercial setting. The milk protein response may be due to the increased supply of methionine as the first limiting amino acid or may be a consequence of improved amino acid profile as represented by the LYS:MET ratio.

Amino acid parameters:	Herd 1		Herd 2	
	Control	RPMet	Control	RPMet
MET % MP	2.31	2.56	2.37	2.62
LYS % MP	7.64	7.62	7.77	7.75
LYS:MET	3.31	2.97	3.28	2.96
Met, g above req.	0	6	5	11
Lys, g above req.	16	16	28	28

RPMET effects:

Variable	Control	RPMet	SE	P
Milk (kg)	31.3	31.5	0.85	.31
Milk fat (%)	3.54	3.50	0.17	.81
Milk fat (kg)	1.101	1.095	.050	.93
MUN (mg/dl)	15.78	15.50	.13	.11
Milk crude protein (%)	3.00	3.06	.014	.01
Milk protein (kg)	0.937	0.963	0.026	.01

Key Words: RPMet, Milk Protein

T169 Rumen undegradable protein characterization of three protein sources. W. H. Kolath*[1], P. L. Bond Jr.[2], and M. S. Kerley[1], [1]*University of Missouri - Columbia,* [2]*Mid South Milling, Memphis, TN*.

Rumen undegradeable protein (RUP) is commonly used in dairy lactation diets to increase milk production and protein content. The objective of this study was to determine the RUP value of two blended protein sources (Apcon 1 and Apcon 2; Mid South Milling). Fish meal (Special Select, Omega Protein Inc.) was used as the control standard. Twenty-four single-phase continuous culture fermentors with a dilution rate of 6% hr^{-1} were used to determine the rumen undegradeable protein value of the three protein sources. Four treatments were fed, a control diet (C) consisting of soyhulls and purified cornstarch, Apcon 1 + C, Apcon 2 + C, and fish meal + C. The C was fed at 36g day^{-1} and the protein sources were added at 9g day^{-1}. True DM and OM digestibility was greatest ($P < 0.05$) for the Apcon 1 and fish meal diets. Microbial efficiency was similar among the three protein sources and lower ($P < 0.05$) for C. The RUP nitrogen was greatest ($P < 0.05$) for Apcon 2 and was similar ($P > 0.05$) among the other treatments. The RUP amino acid values were similar to the RUP nitrogen data. Cecamized roosters were fed 15g of effluent to determine the digestibility of the protein sources. The amino acid digestibilities of Apcon 1, 2 and fish meal were 69.90, 69.31 and 73.96 respectively. We concluded that Apcon 1 and Apcon 2 can be viable alternatives for post-ruminal delivery of amino acids.

	Treatment			
	Apcon 1	Apcon 2	Fish Meal	Control Diet
True DM Digestability	84.16	71.69	85.51	68.52
True OM Digestability	79.95	72.02	82.24	68.19
Microbial Efficiency	12.56	12.50	14.42	9.10
Ammonia (mg/mL)	2.51	6.54	23.14	7.50
% RUP Nitrogen	52.43	82.30	62.37	62.89
% RUP Amino Acid	38.39	59.82	46.75	
Amino Acid Digestability (%)	69.90	69.31	73.96	

Key Words: Rumen undegradable protein, Fish meal, Continuous culture

T170 Effects of nonfiber carbohydrate source and protein degradability on lactation performance and ruminal pH of Holstein cows. C. C. Larson* and M. B. Hall, *University of Florida, Gainesville, Florida, USA*.

The effect of nonfiber carbohydrate (NFC) source and protein degradability on milk yield and composition and dry matter intake (DMI) were evaluated using 38 multiparous Holstein cows in a three period (21 d) partially balanced incomplete latin square design with a 3x2 factorial arrangement of treatments. Ruminal pH was evaluated with 6 ruminally cannulated dairy cows within the group. Dietary

treatments included three NFC sources (ground corn=starch=ST; molasses+sucrose=sugar=SU; and citrus pulp=soluble fiber+sugar=SF) and two concentrations of ruminally undegradable protein (+ or -RUP) achieved by the addition or omission of expeller soybean meal (SoyPlus). The total mixed rations were isonitrogenous and provided ad libitum. Milk yield and DMI were measured daily. Milk samples were taken on days 15, 17, and 19 of the period for composition analysis. Feed efficiency (FE) was calculated as 3.5% fat- & protein-corrected milk kg / DMI kg. Data were analyzed using PROC MIXED with orthogonal contrasts (ST vs SF+SU; SF vs SU). Data presented are least squares means. DMI was affected by NFC (P=0.09), but not RUP (P=0.64). SU gave a greater DMI than SF (P=0.08). NFC affected milk yield (P=0.01), but RUP did not (P=0.82). Cows fed SU had higher milk yield than SF (P<0.01), NFC*RUP was significant for milk yield for the contrast of ST vs SF+SU (P=0.05). Milk fat kg was not affected by NFC (P=0.26) or RUP (P=0.69), but ST vs SF+SU differed for NFC*RUP (P=0.07). Milk protein kg was only affected by NFC with ST greater than SU+SF (P<0.01), and SU greater than SF (P=0.06). Milk urea N was affected by NFC (P=0.05) and RUP (P=0.07) with ST yielding greater values than SF+SU (P=0.02). FE tended to differ for NFC*RUP (P=0.10), with ST differing from SF+SU (P=0.04). Rumen pH differed with NFC (P<0.01), RUP (P=0.02), and NFC*RUP (P<0.01). We conclude that manipulation of dietary NFC source and protein degradability may be used to modify lactation performance.

Item	ST-RUP	ST+RUP	SF-RUP	SF+RUP	SU-RUP	SU+RUP
DMI, kg	24.9	25.0	24.0	23.7	25.1	24.6
Milk, kg	41.0	39.1	38.0	38.6	40.1	40.9
Fat, kg	1.37	1.30	1.27	1.37	1.38	1.39
Protein, kg	1.13	1.06	1.01	0.98	1.05	1.05
Feed eff	1.58	1.48	1.51	1.58	1.53	1.56
MUN, mg/dl	13.6	13.2	13.1	12.1	12.8	12.2
Rumen pH	5.99	5.98	6.11	6.03	5.83	6.07

DMI = dry matter intake; Feed eff = 3.5% fat- & protein-corrected milk kg/DMI kg; MUN = milk urea nitrogen

Key Words: Nonfiber carbohydrates, Protein degradability, Milk production

T171 Production and reproductive performance of dairy herds fed different amounts of phosphorus. T. D. Edwards*, S. K. Tallam, and Z. Wu, *Pennsylvania State University*.

Field data were analyzed for the first 7 mo of an on-going three-year study to evaluate the lactation and reproductive performance of dairy cows fed differing amounts of P. Twenty-six farms in Northern and Central PA ranging from 41 to 1050 cows in size were categorized into low and high dietary P groups. The participating herds were chosen based on their ration formulation before beginning the study. The group included 16 herds fed P at $\geq$ 0.42% of the diet DM, and 10 herds fed P at $\leq$ 0.40% of the dietary DM. Feed samples were collected, and monthly DHIA reports were obtained. Reported data were based on herd averages of two quarterly samples for dietary P concentration, and June through December monthly DHIA reports for cows freshening during that time period. This resulted in 1194 and 943 cows for the low and high P groups, respectively, that contributed to the milk yield data. Of these, 474 and 261, respectively, were confirmed pregnant in that time frame, and used to calculate the reproductive measures. Analysis of data used herd as the experimental unit. The dietary P averaged 0.38 and 0.44% for the two groups, respectively. Milk yield was associated with large herd variation. Overall, there was no effect of dietary P on milk production or reproductive performance.

Item	Low P (n=16)	High P (n=10)	SEM	*P*
Dietary P, %	0.38	0.44	0.01	0.01
Milk, kg/d	32.8	34.0	1.4	0.55
Milk fat, %	3.92	3.74	0.10	0.25
Milk protein, %	3.02	3.00	0.01	0.29
Days to 1^{st} service	87.6	80.7	3.5	0.19
Days open	92.2	99.9	3.6	0.14

Key Words: Phosphorus, Reproduction, Dairy cows

T172 The new French available phosphorus allowances for ruminants. F. Meschy and A. Offner*, *Institut National de la Recherche Agronomique Paris France*.

Faced to new challenges as safety of animal products and environmental concerns, a re-assessment of nutritional allowances is needed. Excessive phosphorus (P) runoffs in the animal wastes contribute to the deterioration of groundwater (eutrophication); in France, two thirds approximately of the 300 000 t. of P annually rejected by the livestock productions come from the ruminants. Thus It seems necessary to revalue the level of P supply to the ruminants. A meta-analysis of literature data where faecal endogenous losses were measured by isotopic dilution of P and some recent experimental data allow a new nutritional standard based on available (absorbed) P. Major changes related to former systems concern maintenance requirement (MR) and principally the true absorption coefficient (TAC) of the components of the diet. Only the irreducible part of faecal endogenous losses corresponds to the MR and is strongly linked to salivary P production; for this reason MR (g/d) is now related to dry matter intake (DMI; kg/d) and body weight (BW; kg). MR = 0.83 DMI + 0.002 BW (n = 68, R2 = 0.89, rsd = 1.05) for cattle and MR = 0.905 DMI + 0.3 + 0.002 BW (n = 192, R2 = 0.95, rsd = 0.17) for small ruminants. We adopted the allometric equations of the AFRC (1991) for growth requirement for cattle as well as for small ruminants; The pregnancy requirement is assessed by AFRC (1991) equation for cow and by 0.4 and 0.6 g of P/day/fetus for ewe and goat respectively. The lactation requirement is set at 0.9 (cow), 0.95 (goat) and 1.5 (ewe) g of P/kg milk. The wide variations showed by TAC values of feedstuffs (from 0.6 for grass silage or alfalfa hay to 0.9 for sugar beet pulps) support the evaluation of dietary P supply on available P basis (total P x TAC). Our literature review did not show any significant difference between good inorganic sources of P; the TAC value for feed phosphates is set at 0.65 %. This re-assessment leads to a reduction of around 15 % of dietary P supply that may allow a P reduction in ruminant wastes of around 25 %. These new recommendations are in good agreement with recent international standards.

Key Words: Phosphorus, Requirements, Ruminants

T173 Tolerance of inorganic selenium in wether sheep. L. A. Cristaldi, L. R. McDowell*, C. D. Buergelt, N. S. Wilkinson, and F. G. Martin, *University of Florida, Gainesville, FL*.

This experiment evaluated the maximum tolerable level of selenium fed to growing wether lambs for one year. Sodium selenite was added to provide 0.2, 2, 4, 6, 8, and 10 ppm Se to a basal diet. Thirty-nine crossbred wether lambs initially weighing 22.8 $\pm$ 3.3 kg were randomly allotted to one of six treatments. Blood samples were collected and liveweight gain determined at 28 d intervals and tissue samples were collected at experiment termination. Serum and whole blood, wool, hooves, bile and five tissues were analyzed for selenium concentrations. Five tissues at experiment termination were microscopically evaluated for tissue breakdown due to selenium toxicosis. Also five enzyme concentrations and albumin were determined that are suggestive of selenium toxicosis. Lamb body weights were not influenced by dietary selenium concentrations (P < 0.01). Both serum and whole blood selenium concentrations increased at each collection period as dietary selenium level increased (P < 0.01) and the serum had a dietary selenium level x time interaction (P < 0.01). The whole blood selenium content was 2-3 times greater than serum selenium content. There was a strong positive correlation (r = 0.92) between serum and whole blood selenium level. All tissues and wool, hoof, and bile selenium concentrations increased as dietary selenium level increased (P < 0.01). Liver had the highest selenium concentration followed by the kidney in all but the lowest treatments. Both gross and microscopic evaluation of tissues revealed no significant lesions for any treatment groups. There was no apparent pathological suggestion of selenosis based on tissue evaluation. Albumin and serum enzyme levels suggestive of tissue breakdown as a result of selenosis did not vary (P > 0.15) among the treatment, and enzymes were within their respective normal ranges. These results suggest that $\leq$ 10 ppm dietary selenium is not toxic to wether lambs over the course of a year. It seems plausible, therefore, to consider the maximum tolerable level of selenium for ruminants to be considerably higher than 2 ppm.

Key Words: Selenium, Sheep , Tolerance

T174 Effect of diet on biotin balance in sheep. T. E. Peterson*[1], L. R. McDowell[1], R. J. McMahon[1], W. M. Seymour[2], N. S. Wilkinson[1], F. G. Martin[1], and P. R. Henry[1], [1]*University of Florida, Gainesville, FL,* [2]*Roche Vitamins Inc., Parsippany, NJ.*

Eight wether sheep were utilized in an experiment to determine the effect of diet forage: concentrate ratio on biotin balance. The pelleted diet included alfalfa, corn, soybean meal and corn oil. The four diets were formulated in percentages to contain forage:concentrate ratios as follows: A, 95:5; B, 50:50; C, 30:70; D, 10:90. Sheep were placed in metabolic crates and fed their respective diet for a period of ten days. The experiment was constructed as a 4x4 Latin Square in which the four groups of two sheep were fed a different diet (A-D) in each of the respective treatments. For each diet change there was a 20 d period; 10 days of adaptation with the 50:50 forage to concentrate diet followed by 10 days of the designated treatment diet. Feedings were conducted twice daily; 8:00am and 4:00pm. Total collection of feces and urine for determination of biotin balance was done twice daily on days 8, 9, and 10 of each period. Analyzed biotin for the four diets was 0.176, 0.157, 0.122 and 0.096 μg/g, respectively. Biotin balance was negatively higher (P<0.05) for the forage:concentrate ratio of 30:70 compared to the highest forage or concentrate diets due to the high (P<0.05) fecal biotin concentrations.

Table 1. Biotin (μg) balance data (3d)[1].

	Diet A	Diet B	Diet C	Diet D
Feed	595±29^a	552±5^a	385±17^b	259±25^c
Feces	2588±201^b	3464±498^{ab}	4763±978^a	2588±211^b
Urine	402±76	279±58	371±40	378±76
Balance	-2395±229^b	-3191±524^{ab}	-4748±961^a	-2707±221^b

[1]Means ± S.E. ^{abc}Means with different superscripts, within a row, differ (P<0.05).

Key Words: Biotin, Sheep, Balance

T175 Effect of VFA on [^{15}N]ammonia utilization for amino acid and urea synthesis by ruminal epithelial and duodenal mucosal cells isolated from growing sheep. M. Oba*[1], R. L. Baldwin, IV[2], S. L. Owens[1], and B. J. Bequette[1], [1]*Department of Animal and Avian Sciences, University of Maryland, College Park, MD,* [2]*Bovine Functional Genomics Laboratory, ANRI, USDA-ARS, Beltsville, MD.*

The objective was to determine effects of VFA on the extent of assimilation of ammonia N into amino acids and urea by isolated ruminal epithelial (REC) and duodenal mucosal cells (DMC) in short-term incubations. Cells were isolated from growing Polypay ram lambs (n=4) fed a mixed forage-concentrate diet, and incubated for 90 min in media containing [^{15}N]ammonia and glucose plus either acetate or propionate (5 mM each). Production of Ala, Asp, Glu, Arg + citrulline, and urea, and ^{15}N enrichment were determined by gas chromatography-mass spectrometry. Data are presented as a production rate per 10^6 cells during 90 min incubations. In both cell types, the total release of Ala, Asp, Glu, Arg + citrulline, and urea was not affected by VFA treatment. However, for REC, assimilation of ammonia N into Glu (0.51 vs. 0.40 nmol; $P < 0.05$) was greater, and that into Asp (0.19 vs. 0.15 nmol; $P = 0.07$) and Ala (0.64 vs. 0.40 nmol; $P = 0.10$) tended to be greater for acetate compared to propionate treatment. However, ammonia N was not incorporated into Arg + citrulline and urea by REC. For DMC, assimilation of ammonia N into Ala, Asp, and Glu was also greater for acetate (1.57, 0.69, and 2.07 nmol, respectively) compared to propionate treatment (0.86, 0.46, and 1.37 nmol, respectively; all $P < 0.05$). Utilization of ammonia N for Arg + citrulline synthesis tended to be greater for acetate compared to propionate treatment (0.75 vs. 0.49; $P = 0.08$), but ammonia N was not incorporated into urea. In summary, ruminant gut tissues are capable of assimilating ammonia N into amino acids, and VFA type affects the extent of ammonia N utilization for amino acid synthesis.

Key Words: Ruminal epithelial cells, Duodenal mucosal cells, Ammonia utilization

Production, Management, and the Environment

T176 Use of electronic rumen boluses for identification of sheep in the U.S. G. Caja*[1], D. L. Thomas[2], M. Rovai[1], Y. M. Berger[2], and T. A. Taylor[2], [1]*Universitat Autonoma de Barcelona, Bellaterra, Spain,* [2]*University of Wisconsin-Madison.*

A total of 791 sheep in two research flocks at the University of Wisconsin-Madison were used to study the effectiveness of three types of electronic rumen boluses for individual animal identification. One flock consisted of dairy sheep and the other of meat and wool sheep. All sheep carried at least one ear tag with a unique number for identification. The three types of electronic rumen boluses consisted of ISO radio frequency transponders of different technology encased in capsules of different size and construction: B1 (full duplex; 20×74 mm, 70 g, white plastic cover), B2 (half duplex; 21×68 mm, 79 g, white ceramic cover), and B3 (half duplex; 12×42 mm, 16 g, brown ceramic cover). Boluses were given orally to all sheep (rams, adult ewes, ewe lambs) on a farm on the same day by both trained and untrained operators using appropriate balling guns. Bolus readability was checked immediately before and after administration to ensure that only functional boluses were administered and present in each sheep. Boluses in all sheep were read 1 d following administration, approximately one wk later, and at approximately 1 mo intervals thereafter through d 102 using handheld transceivers. Animals ranged in weight from 25 to 145 kg in body weight at the time of bolus administration, and there were no injuries or deaths from bolus administration. Application time averaged 71.4 s and was affected by operator ($P < 0.05$). Application time was greater ($P < 0.05$) for rams than for adult ewes or ewe lambs. Approximately 102 d after administration, bolus readability varied by sheep group (rams, 88.0%; ewes, 92.0%; ewe lambs, 86.9%; $P < 0.05$) and bolus type (B1, 63.2%; B2, 99.5%; and B3, 98.7%; $P < 0.001$). The B1 bolus was insufficiently readable for ICAR requirements of 98% readability, but the B2 and B3 boluses were very effective in electronic identification of sheep.

Key Words: Sheep, Electronic identification, Rumen bolus

T177 Effects of bolus features on retention performance in the electronic identification of cattle. J. J. Ghirardi, G. Caja*, D. Garin, and M. Hernandez-Jover, *Universitat Autónoma de Barcelona, Spain.*

A total of 782 crossbreed calves were used to evaluate the retention rate of 12 prototypes of electronic identification boluses during fattening. Male and female calves were fed with concentrate (1.89 Mcal EN_f; and, 15.0% CP, as feed) and straw ad libitum and slaughtered at approximately 480 and 380 kg BW, respectively, before one year of age. In order to determine the anatomical limit for a bolus passing through the gastrointestinal tract, the size of the reticulo-omasal orifice was measured at slaughter in a total of 70 males and 42 females. Bolus prototypes consisted of two series of ceramic capsules of different features containing a glass encapsulated half duplex transponder (31.8×3.8 mm). Series #1 (n=544) consisted of six types of boluses with the same external dimensions (68×21 mm) but different specific gravity (2.39, 2.9, 2.79, 2.95, 3.12 and 3.36); and series #2 (n=238) consisted of different commercial prototypes varying in external dimensions and specific gravity (39×15, 3.08; 51×15, 3.00; 64×16, 3.63; 68×17, 3.60; 62×19, 3.60; and, 66×20, 3.11). Total weights ranged from 20 to 75 g. Boluses were applied to milk fed calves (2 to 5 wk of age) restrained in a head-locker using a balling gun. Three calves in series #1 (0.6%) could not be applied at the first attempt due to difficulties in swallowing and were applied one wk later. Bolus retention was checked at mo 1, 5 and 7, and at slaughter by using a handheld transceiver with a stick antenna. Retention rate until slaughter varied quadratically ($R^2 = 0.96$) with a plateau according to bolus weight for the two series: #1 (89.5 to 100%) and #2 (76.2 to 100%). Four boluses were retrieved from the abomasum. Minimum weight and specific gravity to reach the 98% retention rate established by ICAR were estimated to be 65 g and up to 3.00 for cattle. Diameter of reticulo-omasal orifice differed between males (32.5 ± 1.4 mm) and females (29.9 ± 1.3 mm) and were greater than diameters of retained boluses. As a conclusion, bolus features need to be optimized in order to achieve their maximum retention rate in cattle.

Key Words: Transponder, Electronic identification, Traceability