T172 Rumen and metabolic acidosis in dairy goats are independent. S. Giger-Reverdin*[1], M. DesNoyers[1], C. Duvaux-Ponter[2], and D. Sauvant[2,1], [1]*Institut National de la Recherche Agronomique*, *Paris, France*, [2]*Institut National de la Recherche Agronomique Paris-Grignon*, *Paris, France*.

The occurrence of rumen acidosis is increasing in high producing dairy herds. Its mechanism and its impact on blood pH and blood bicarbonates need further investigation. Eight cannulated dairy goats in mid-lactation were given two total mixed diets: control (C) and acidogenic (A), differing in the % of concentrate (30 vs 60 %), in a 4 week cross-over design. Rumen pH, blood bicarbonates and blood pH were measured before the morning meal (T0) and every 2 hours thereafter for 8 hours (T2, T4, T6 and T8). Rumen pH (pHr) was significantly lower after the A compared to the C meal (5.94 vs 6.26). There was a significant goat effect (mean goat values varied between 5.58 and 6.48 for diet A and 6.03 and 6.63 for diet C). Chewing index (CI, min per kg dry matter intake) explained part of the variation because more buffers enter the rumen when chewing time is longer: pHr = 5.38 + 0.00288 CI (r = 0.74, n = 16, rmse= 0.20). Blood pH (pHb) and blood bicarbonates (Bb) were significantly higher after the A meal compared to the C meal (pHb: 7.41 vs 7.39 and Bb: 25.4 vs 24.7 mmol/l, respectively) and were highly correlated. Blood pH was not correlated with rumen pH, except at T4 (r = -0.71, n = 8, rmse = 0.056). Blood bicarbonates were highly correlated with rumen pH at T2 (r = -0.69, n = 8, rmse = 1.02) and T4 (r = 0.79, n = 8, rmse = 0.79). There was a significant goat effect. The lack of correlation between rumen and blood pH emphasizes the fact that goats can suffer from rumen acidosis without suffering from metabolic acidosis. The chewing index was negatively correlated with blood bicarbonates (r = - 0.59, n = 16). This indicates that goats which chew less extract less bicarbonates from blood. The higher level of bicarbonates might counteract the decrease in rumen pH and prevent metabolic acidosis as confirmed by the negative relationship between blood bicarbonates and rumen pH, particularly at times when rumen pH is at its lowest. Chewing time influences blood bicarbonates which affects blood pH. The individual differences between goats confirm what is generally observed in a dairy herd in that only some animals suffer from acidosis.

Key Words: Rumen acidosis, Metabolic acidosis, Individual effect

T173 Effects of chronic metabolic acidosis on acid-base balance and plasma free amino acids in lambs. N. E. Odongo[1], J. E. Las*[1], S. Wadud[1], O. AlZahal[1], M. Lindinger[1], A. Shoveller[1], J. C. Matthews[2], and B. W. McBride[1], [1]*University of Guelph*, *Guelph, Ontario, Canada*, [2]*University of Kentucky*, *Lexington*.

Metabolic acidosis often leads to loss of body protein due mainly to accelerated protein breakdown in muscle. The objective of the current study was to characterize the effects of chronic metabolic acidosis on acid-base balance and plasma free amino acids in lambs. Twelve fully fleeced yearling wether lambs (Canadian Arcott, 54.3 ± 6.7 kg, body weight) were fed either a control diet (CD, canola meal, dietary cation-anion difference; DCAD = 184 mEq/kg DM, n=5) or an acidosis diet (AD, NutriChlor™ 18–8, DCAD = –206 mEq/kg DM, n=6) in a randomized complete block experiment. Lambs were individually housed and limit-fed dehydrated alfalfa pellets (DM, 900 g/kg; CP, 220 g/kg DM and 1.2 Mcal NE_g /kg DM) at 1 kg DM/d offered twice daily at 0700 and 1500. Lambs were fitted with left jugular vein catheters (0.86 mm i.d., 1.32 mm o.d.) 2 days prior to the commencement of the trial for blood sampling which was obtained daily at 1100 on day 1 to day 10. The blood was analyzed for pH, gases, hematocrit, and plasma ions. Urine samples were also obtained daily at 1100 for urine pH determination. On day 11, lambs were slaughtered by captive bolt stunning and mucosal tissue samples obtained from the rumen, ileum and colon, the liver, kidney and muscles. The AD induced a non-respiratory systemic acidosis (pCO_2, 37.4 vs. 38.3; pO_2, 38.9 vs. 40.3; $P > 0.05$, CD vs. AD, respectively). The AD was associated with reduced rumen pH (6.25 vs. 5.70, $P < 0.05$), reduced blood pH (7.47 vs. 7.39, $P < 0.05$), reduced urine pH (8.13 vs. 6.09, $P < 0.05$) and reduced strong ion difference (42.5 vs. 39.5, $P < 0.05$, CD vs. AD, respectively). The AD reduced ($P < 0.05$) the anion gap, the concentration of blood glucose, hemoglobin, base excess and bicarbonate. The AD increased ($P < 0.05$) the concentration of electrolytes K^+, Cl^- and Ca^{2+} in blood and plasma free concentrations of glycine and glutamine. These results show that chronic metabolic acidosis altered acid-base parameters and amino acid concentrations.

Key Words: Metabolic acidosis, Acid-base balance, Protein mobilization

T174 The severity of ruminal acidosis in primiparous Holstein cows near parturition. G. B. Penner*[1,2], K. A. Beauchemin[2], and T. Mutsvangwa[1], [1]*University of Saskatchewan*, *Saskatoon, SK, Canada*, [2]*Agriculture and Agri-Food Canada*, *Lethbridge, AB, Canada*.

The objective of this study was to determine the risk of acidosis near parturition in primiparous cows. We hypothesized that additional concentrate allocation pre-partum would improve rumen adaptation and reduce the severity of ruminal acidosis after parturition. Fourteen ruminally cannulated Holstein heifers were blocked by expected calving date and body condition score. Cows were assigned to: 1) control treatment consisting of a far-off diet (forage:concentrate, F:C = 80:20) fed from -60 to -25 d and a close-up diet (F:C = 54:46) fed from -24 d until parturition; or 2) an intensive grain feeding program consisting of 4 pre-partum diets, step 1 (F:C = 68:32) fed from d -60 to -43, step 2 (F:C = 60:40) from d -42 to -25, step 3 (F:C = 52:48) from d -24 to -13, and step 4 (F:C = 46:54) from d -12 until parturition. All cows received the same diet post-partum. Ruminal pH was measured from d -5 to d 5 relative to parturition using a continuous indwelling ruminal pH measurement system. Mild acidosis was considered to occur when ruminal pH was < 5.8, severe acidosis when ruminal pH was < 5.5, and acute acidosis when ruminal pH < 5.2. The data were analyzed accounting for repeated measures. The main effect of treatment was not significant. DMI increased ($P < 0.01$) after parturition. Minimum ($P < 0.01$), maximum ($P < 0.01$) and mean ruminal pH ($P < 0.01$) decreased after parturition. The number of daily episodes of mild acidosis decreased to 1.6 on the day of parturition from 3.4 during the pre-partum period, but increased after parturition to 9.4 ($P < 0.01$). Consequently, the duration of mild acidosis increased ($P < 0.01$) post-partum such that ruminal pH was below 5.8 for 7.88 h/d. The number and length of severe and acute episodes of acidosis also increased ($P < 0.05$) post-partum. This study shows that the incidence and severity of ruminal acidosis increases immediately post-partum emphasizing the need to implement feeding strategies to reduce this risk.

Key Words: Ruminal acidosis, Parturition, Rumen fermentation

T175 Effects of rumen acid-load from feeds on ruminal pH, dry matter intake, fiber degradability and milk production in the lactating dairy cow. B. Rustomo*, O. AlZahal, J. P. Cant, M. P. Fan, T. F. Duffield, N. E. Odongo, and B. W. McBride, *University of Guelph*, *Guelph, Ontario, Canada*.

The objective of this study was to evaluate the effects of rumen acid-load from feeds on ruminal pH, dry matter intake, fiber degradability and milk production in lactating dairy cows. Two isoenergetic (NE_l =1.73 Mcal/kg DM) and isonitrogenous (CP = 22.1% DM) concentrate diets with either a low (LAV) or high acidogenic value (HAV) were fed in a corn silage/alfalfa haylage based TMR. The diets, fed for ad libitum intake, were offered twice daily at 0700 and 1300 and DM intake recorded daily. Four rumen-fistulated dairy cows (230 ± 30 DIM) were randomly assigned to one of the two treatments in a crossover design with two periods of 3 wk (14 d adaptation, 7 d data collection) each. The cows were milked twice daily at 0500 and 1500, and milk samples pooled twice weekly for compositional analysis. Ruminal pH was measured continuously for 3 d using an indwelling pH electrode. Forage degradability was determined using the in situ technique. Data were analyzed using PROC GLM of SAS using the model: $Y_{ijk} = \mu + \alpha_i + \beta_j + \tau_k + \varepsilon_{ijk}$, where Y_{ijk} = dependent variable, μ = overall mean, α_i = effect of cow ($_i$ = 1, 2, 3, 4) β_j = effect of period ($_j$ = 1, 2) τ_k = effect of treatment ($_k$ = 1, 2), and ε_{ijk} = random residual error. The repeated measurements of ruminal pH were analyzed using PROC MIXED of SAS. Increasing dietary AV decreased maximum ruminal pH, but had no effect on minimum and mean daily ruminal pH. High AV cows had longer time spent below ruminal pH 5.6 and greater area below ruminal pH 5.6 to 6.0 than the LAV cows. The time distribution curve of HAV cows was shifted to a lower pH range and tended to have longer time spent at ruminal pH 5.0 to 5.6 and shorter time spent at ruminal pH 6.2 to 6.8 than LAV cows. Increasing dietary AV reduced the 72 h in situ NDF degradability of alfalfa/grass hay, increased milk yield, lactose %, lactose yield and milk protein yield. These results emphasize the significance of ruminal pH alterations when evaluating the effect of feed AV on ruminal pH and suggest that feed AV could be used to predict ruminal pH changes in vivo.

Key Words: Acidogenic value, Fiber degradability, Ruminal pH

T176 Effects of rumen acid-load from feed and forage particle size on ruminal pH, feed intake and milk production and composition. B. Rustomo*, O. AlZahal, N. E. Odongo, T. F. Duffield, and B. W. McBride, *University of Guelph*, *Guelph, Ontario, Canada*.

This study evaluated the effects of concentrate acidogenic value (AV) and forage particle size (FPS) on ruminal pH, feed intake and milk production and composition in lactating dairy cows. Four rumen-fistulated dairy cows (114 ± 14 DIM) were randomly assigned to one of four treatments in a 4 x 4 Latin square with a 2 x 2 factorial treatment arrangement. Four isoenergetic (NE_l = 1.5 Mcal/kg) and isonitrogenous (CP = 17.4 % DM) concentrate diets with either a low (LAV) or high AV (HAV) were fed in either a coarse (CS) or finely chopped (FS) corn silage/alfalfa haylage based TMR. Production data were analyzed using PROC GLM of SAS using the model: $Y_{ijkl} = \mu + \alpha_i + \beta_j + \gamma_k + \delta_l + (\gamma \times \delta)_{kl} + \varepsilon_{ijkl}$; where Y_{ijkl} = dependent variable, μ = overall mean, α_i = effect of cow ($_i$ = 1, 2, 3, 4), β_j = effect of period ($_j$ = 1, 2, 3, 4), γ_k = effect of AV ($_k$ = 1, 2), δ_l = effect of FPS($_l$ = 1, 2), $(\gamma \times \delta)_{kl}$ = effect of $\gamma_k \times \delta_l$ interaction, and ε_{ijkl} = random residual error. Repeated measurements of ruminal pH data were analyzed using PROC MIXED. Increasing dietary AV increased rumen acid-load (decreased mean, minimum and maximum ruminal pH), time below rumen pH 5.6 to 6.0 and area below rumen pH 5.6 and 6.0. Increasing FPS increased maximum ruminal pH and reduced time below pH 6.4 to 6.8 for HAV diets whereas increased FPS increased time below pH 6.4 to 6.8 for LAV diets. Time distribution for HAV diets was shifted downward to a lower pH range compared to the LAV diets. Increasing dietary AV had no effect on DMI but reduced OM and NDF intake. There was a correlation (r = -0.54, P = 0.03) between milk fat content and time below pH 5.6. The correlation between time below pH 5.6 and rumen acid-load was stronger (r = 0.58, P = 0.02) than that between time below 5.6 and the intake of starch, r = 0.40; NFC, r = 0.20; FPS, r = 0.005 and peNDF, r = 0.26; $P > 0.05$). These results suggest that coarse FPS can attenuate ruminal pH drops. However, the ameliorating effects of FPS on ruminal pH are more apparent in HAV diets than in LAV diets.

Key Words: Acidogenic value, Forage particle size, Ruminal pH

T177 Effect of physically effective fiber on chewing and ruminal pH of dairy cows fed diets containing barley or corn grains. W. Z. Yang* and K. A. Beauchemin, *Research Center, Agriculture and Agri-Food Canada*, *Lethbridge, AB, Canada*.

Two studies were conducted to determine the effects of physically effective (pe) NDF content of dairy cow diets on chewing and ruminal pH as influenced by type of grain. Barley and corn grains were each used in separate feeding studies. Each study was a replicated 4 x 4 Latin square design using eight lactating dairy cows with ruminal cannulas. Alfalfa silage, chopped short (5/16") and long (3/4"), was the forage in both studies. In each study, four diets were formulated using the short and long silage, combined with two forage:concentrate (F:C) ratios (35:65 or 60:40, DM basis). The peNDF contents of the diets were determined using the Penn State Particle Separator with two sieves and a pan, and the NDF content of the diets. The peNDF contents ranged from 9.6 to 19.8% for barley diets, and from 10.7 to 17.5% for corn diets (DM basis). Data were analyzed using the mixed model of SAS to account for effects of treatment (fixed) and square, period within square, cow within square (random). For diets containing barley grain, increasing particle length increased total chewing time (min/kg of DMI) for the high forage diet (34.6 vs 40.1), but not for the low forage diet (31.3 vs 30.9). However, increasing the particle length of the low forage diet increased mean ruminal pH from 5.86 to 6.17 and reduced the duration of ruminal acidosis (pH<5.5) from 7.8 to 5.9 h/d. With corn diets, increasing particle length increased mean ruminal pH of cows fed low F:C ratio (5.99 vs 6.26), but not high F:C ratio (6.46 vs 6.55). For both grain types, higher F:C ratio increased chewing activity and mean ruminal pH, and reduced ruminal acidosis. The results indicate that acidosis can be reduced by increasing the peNDF content of the diet, either by using longer chopped forage or by increasing the proportion of forage in the diet. Formulating diets for higher peNDF content to prevent ruminal acidosis is particularly beneficial when using barley grain, because cows fed barley are at greater risk of acidosis than those fed corn.

Key Words: Physically effective NDF, Grain source, Ruminal acidosis

T178 Sampling ruminal pH: How many days and how frequent within day? C. Leonardi*[1], K. M. Krause[2], and D. K. Combs[3], [1]*Louisiana State University*, *Baton Rouge*, [2]*West Virginia University*, *Morgantown*, [3]*University of Wisconsin*, *Madison*.

This study evaluated how sampling schedule influenced statistical interpretation of the dietary effects on ruminal pH in lactating cows.

Data collected in two published Latin Square studies were utilized (JDS 85:1947: A, JDS 86:2433: B). Ruminal pH was continuously measured in each period for 5 d in A and 3 d in B using indwelling electrodes and averaged by hour such that each cow had 24 observations per day. Average treatment pH, calculated using the hour by treatment least square means within experiment, ranged 0.27 pH units for A and 0.50 pH units for B. In trial A equal portions of TMR were fed every 12 h, where in B 65% of the TMR was fed in the morning and 35% 12 h later. Effect of forage particle size (FPS), grain fermentability (GF) and their interaction were tested in both studies. In both studies an effect of GF was observed ($P < 0.05$). The effect of FPS was significant in A, but not in B. The GF by FPS interaction was not significant in either study. Data were re-analyzed using 3 abbreviated sampling schedules within day and for 1, 3 or 5 (only for A) consecutive days within period, utilizing rumen pH measured: 1) 8 h post am feeding, 2) every 4 h for 24 h, and 3) and every 2 h for 12 h after the am feeding. Data were analyzed as Latin Square designs utilizing the mixed procedure of SAS with repeated measures. Sampling schedules were compared by the capability to detect a treatment effect ($P < 0.05$). In study A, sampling for either 3 or 5 d utilizing either of the 3 sampling schedules produced similar results. When only 1 d was utilized in the analysis, sampling every 2 h over a 12 h period detected both treatment effects ($P < 0.05$). In study B, 3 d of multiple within day samples were required to detect a GF effect ($P < 0.05$). In contrast to the published analysis, sampling only once a day (1 or 3 d) or every 4 h for 3 d resulted in a GF by FPS interaction ($P < 0.05$). It is recommended to sample ruminal pH across multiple days and hours. It is important to consider post prandial pattern of ruminal pH when choosing the sampling schedule that will maximize the probability to detect a treatment effect.

Ruminant Nutrition: Growing/Finishing Nutrition – Beef

T179 Intake, digestibility, and performance of crossbred steers fed diets containing high levels of urea[a]. F. H. M. Chizzotti*[1,2], O. G. Pereira[1], L. O. Tedeschi[2], S. C. Valadares Filho[1], M. L. Chizzotti[1,2], L. M. Moura[1], I. C. S. Belo[1], and D. H. Pereira[1], [1]*Universidade Federal de Vicosa*, *Vicosa, MG, Brazil*, [2]*Texas A & M University*, *College Station*.

True protein supplements are the most expensive ingredients in diets of beef cattle. Therefore, substitution of a true protein supplement with a non-protein N source may significantly reduce the diet costs. Studies have demonstrated that animal performance is not affected by using high levels of urea and/or replacing the true protein source by urea. A trial was conducted with twenty-four crossbred steers (Holstein x Zebu), averaging 350 kg BW, distributed in six randomized blocks to evaluate intake and digestibility of nutrients and performance. Steers were fed with four diets (TRT) containing high levels of urea. Diets consisted of 70% corn silage and 30% concentrate, formulated to be isonitrogenous (12% CP, DM basis). Treatments consisted of 0, 0.65, 1.3, and 1.95% of dietary urea (DM basis), which replaced cottonseed meal in the concentrate mixture. The experiment was conducted for 99 d (15 d for diet adaptation and 3 periods of 28 d). For each animal, the DMI was measured daily and samples of feces were collected to determine the diet digestibility using indigestible ADF as a marker. There were no differences ($P > 0.05$) in the intakes of DM, OM, ether extract (EE), CP, NDF, non-fiber carbohydrates (NFC), and TDN among treatments. Additionally, no effects of levels of urea were observed on apparent total digestibility of DM, OM, NDF, EE, and NFC, which were, on average, 70.1, 71.3, 54.0, 84.3 and 86.8%, respectively. CP apparent digestibility increased linearly ($P < 0.05$) with increasing levels of urea, but ADG was not influenced ($P > 0.05$) and averaged 1.14 kg/d. This experiment suggested that levels of urea (up to 1.95% DM) might be fed to crossbreds receiving high forage diets without affecting their growing performance.

[a]Sponsored by CAPES, Brazil

Key Words: Feedlot, Non-protein nitrogen, Protein supplementation

T180 Effect of corn density on growing steer intake and performance. D. M. Larson*, M. L. Bauer, and G. P. Lardy, *North Dakota State University*, *Fargo*.

A trial was conducted to evaluate the effect of corn density on intake and performance of growing steers (288 ± 11 kg initial weight). Previous research indicates a negative effect of decreasing corn density on finishing steer gain efficiency. Sixty crossbred and purebred beef steers were assigned randomly by weight to one of four dietary treatments. The treatments consisted of low density (50.4 kg/L; 39.1 lb/bushel; LD) corn replacing 0%, 33%, 67%, or 100% of high density corn (72.1 kg/L; 56 lb/bushel; HD). The steers were individually fed once daily using a Calan Broadbent feeding system. Body weight was measured every 28 d, individual feed offered recorded daily, and individual feed refusal was recorded weekly. The diet DM was composed of dry-rolled corn (42%), corn silage (35%), mixed hay (15%), concentrated separator byproduct (5%), and supplement (3%) that provided 27.5 mg/kg monensin (DM basis). Calves were implanted with Synovex S on d 0 and were fed for 96 d. Data were analyzed with the MIXED model of SAS with linear and quadratic contrasts of LD level ($P \leq 0.05$). In addition, G:F was analyzed with PROC REG of SAS to determine the effect of % LD inclusion ($P \leq 0.05$). There was no effect of treatment on final BW (455 ±13 kg, $P = 0.90$), ADG (1.74 ±0.06 kg/d, $P = 0.71$), or DMI (10.05 ±0.30 kg/d, $P = 0.57$) or DMI as a percentage of BW (2.73 ±0.08 %, $P = 0.44$). Calculated apparent NEg increased linearly with increasing inclusion of LD corn in the diet (1.13, 1.18, 1.19, and 1.25 ± 0.03 Mcal/kg; 0, 33, 67, 100% LD, respectively, $P = 0.02$). Inclusion of LD corn also improved G:F (167, 174, 173, and 182 ± 5 g/kg; 0, 33, 67, and 100% LD respectively, $P = 0.03$). Regression analysis of G:F indicates an intercept of 167.2 ± 4.8 g/kg ($P < 0.001$) and a regression coefficient of 0.138 ± 0.062 g/kg/% of LD ($P = 0.03$). We conclude that corn with a density of 50.4 kg/L is a suitable substitute for regular density corn. The increase in G:F may be due, in part, to less inhibition of ruminal fiber fermentation due to the decrease of starch content in the LD corn.

Key Words: Steers, Corn density, Growing