IS populations remained constantly chemotactic toward G1000 (main effect, $P<0.05$). Although IS populations were inhibited by fat, chemotaxis to G1000 was unchanged; in contrast, chemotaxis by EN is more complex. Fat might be inhibitory by disrupting membrane structure or more selectively by disrupting the ability to sense a glucose gradient, blinding EN to newly ingested feed.

Key Words: rumen protozoa, chemotaxis, fat inhibition

581 From Redox potential field measurement to its bioenergetic meaning in the rumen. J. P. Marden*[1,2], E. Ungerfeld[3], R. A. Kohn[4], C. Julien[1], E. Auclair[2], R. Moncoulon[1], and C. Bayourthe[1], [1]*Université de Toulouse, INRA, Castanet-Tolosan, France*, [2]*Lesaffre Feed Additives, Marquette-Lez-Lille, France*, [3]*Agriculture and Agri-Food Canada, Lethbridge, Canada*, [4]*University of Maryland, College Park.*

Anaerobic microbial metabolism is driven by free energy change (ΔG) of fermentation reactions, but ΔG can be difficult to estimate in biological systems. Ruminal metabolism is highly controlled by dynamics of dihydrogen (H_2) production and utilization, e.g. methanogenesis ($CO_2 + 4\ H_2 \rightarrow CH_4 + 2\ H_2O$; $\Delta G = \Delta G° + RT \ln [CH_4][H_2O]^2/[CO_2][H_2]^4$) is highly dependent on H_2 availability. Redox potential (E_h), in conjunction with pH, can be used to calculate equilibrium H_2 availability to study ΔG in fermentation systems. E_h is defined as the tendency of a biochemical/chemical system to oxidize (lose electrons to) or reduce (gain electrons from) another system. E_h measurements have been applied in fields as diverse as understanding fermentation in soils to ripening of cheese and maturation of wines. In the rumen, this variable was initially measured during the late 1950's in sheep and later in goats and cattle. Some studies reported a clear relationship between E_h and metabolic rate of rumen microbes when animals were fed grain and hay diets. E_h can be used in combination with pH and temperature to calculate equilibrium H_2 partial pressure (P_{H2}), based on the Nernst Equation: $rH = -\log P_{H2} = E_h/30 + 2pH$ at 312 K. Since H_2 is readily transferred among organisms in the rumen, it is generally near equilibrium in reality, or moving rapidly in that direction, and is central to the feasibility of major fermentation pathways in the rumen. Three trials: a dry cow model with 8 kg DMI/d (T8) and 2 lactating cow models with 21 (T21) and 28 kg DMI/d (T28) were used to continuously measure pH and E_h over 9 h around the morning meal to finally calculate mean ruminal P_{H2}. Lower DMI was associated with higher estimated P_{H2}, with a 10-fold significant decrease ($P<0.001$) at each feeding level (T8 vs. T21 & T21 vs. T28). Calculated P_{H2} values from simultaneous and continuous E_h and pH measurements can be valuable to study ΔG of processes highly dependent on H_2 availability, like methanogenesis, propionate formation, or even microbial growth. Processes dependent on releasing H_2 (e.g acetate and butyrate formation), are also dependent on H_2 concentration.

Key Words: ruminal redox potential, free energy, partial pressure of H_2

Ruminant Nutrition: Ruminant Nutrition 2

582 Pharmacological amounts of nicotinic acid can reduce isoproterenol-stimulated lipolysis in cattle, but also reduce feed intake. K. S. Spivey, E. C. Titgemeyer*, and B. J. Bradford, *Kansas State University*, *Manhattan*.

Six Holstein steers (225 kg) were used in a series of experiments to determine if pharmacological supplies of nicotinic acid could reduce lipolysis stimulated by beta-agonists. The ruminally cannulated steers were fed a grain-based diet (72% corn, 12% soybean meal, 10% alfalfa) near ad libitum intake. In the first trial, nicotinic acid was continuously infused into the abomasum at 0, 2, 4, 8, 16, or 32 g/d in a 6x6 Latin square with 1-d periods. Steers were challenged with a pulse dose of isoproterenol (ISOP; 0.225 mg) with blood samples collected 8 min after ISOP to measure plasma NEFA. Results were inconclusive, and 4 of 6 steers demonstrated reductions in feed intake during the trial. In a second trial, the same steers were used in a replicated 3x3 Latin square with continual infusion of nicotinic acid in amounts of 0, 8, or 16 g/d. ISOP was dosed at 0.1125 mg, and blood samples were collected just prior to and 8 min after ISOP. Nicotinic acid at 16 g/d inhibited ($P<0.05$) the ISOP-stimulated increases in plasma NEFA concentrations, whereas 8 g/d did not. All 6 steers were then fed 60 mg/d zilpaterol-HCl, and 3 were provided a continual abomasal infusion of 16 g/d nicotinic acid, whereas 3 were infused with water. Steers given 16 g/d nicotinic acid had large reductions in feed intake, and nicotinic acid infusions were terminated after 3 d. Plasma glucose and insulin were somewhat elevated in response to nicotinic acid, even in the face of reductions in feed intake. Following discontinuation of the nicotinic acid infusions, cattle were maintained on their diets for 4 d before they were euthanized. Total liver fatty acids tended ($P=0.16$) to be elevated for steers that had received the nicotinic acid, with C16:0 and C18:1cis-9 demonstrating the largest increases. It appears that nicotinic acid (16 g/d) can inhibit ISOP-stimulated lipolysis, but the large negative effect on feed intake suggests that caution should be exerted when providing pharmacological doses of nicotinic acid to cattle.

Key Words: nicotinic acid, cattle

583 Effects of niacin infusion on transcript and protein abundance of the niacin receptor GPR109A in bovine tissues. B. J. Bradford*, L. K. Mamedova, K. S. Spivey, and E. C. Titgemeyer, *Kansas State University*, *Manhattan*.

Pharmacological effects of niacin (nicotinic acid) are likely mediated by GPR109A, a G protein coupled receptor with affinity for niacin. In most species, GPR109A is expressed primarily in adipocytes and macrophages, accounting for antilipolytic and cutaneous flushing responses to niacin. Tissue distribution of GPR109A has not been thoroughly investigated in cattle. We determined where GPR109A is expressed in cattle and assessed effects of niacin infusion on abundance. Six ruminally-cannulated steers (225 kg) were fed a grain-based diet (with 60 mg/d zilpaterol-HCl) near expected intake. Three steers received continuous abomasal infusion of 16 g/d nicotinic acid in 2 L water, and 3 received water alone. Steers provided 16 g/d niacin had dramatic reductions in feed intake, requiring discontinuation of niacin infusion after 3 d. Thereafter, steers were maintained with no niacin treatment until the end of the planned 7-d period. Steers were then euthanized and tissue samples were collected from tailhead fat, backfat, kidney fat, longissimus muscle, and liver for analysis of GPR109A mRNA by quantitative real-time PCR and protein by Western blotting. The mRNA for GPR109A was found in all tissues analyzed, and was most abundant in liver tissue, despite the fact that it has not been observed in liver of other species. Tailhead and kidney fat contained more mRNA for GPR109A than did longissimus muscle, as expected. Protein analysis by Western blot demonstrated presence of GPR109A protein in all tissues, except 3 of 6 backfat samples. The greatest abundance of GPR109A protein was in tailhead fat, kidney fat, and liver. Niacin treatment had no impact on mRNA or protein abundance of GPR109A in any analyzed tissue ($P>0.17$), but this is confounded by reduced feed intake by niacin and removal of treatments 4 d before euthanasia. The novel identification of the niacin receptor in bovine liver may provide

insight into mechanisms underlying unique physiological responses to pharmacological doses of niacin in cattle.

Key Words: nicotinic acid, GPR109A, niacin receptor

584 Effects of encapsulated niacin on metabolism and production of periparturient dairy cows. S. D. Morey, B. J. Bradford*, L. K. Mamedova, and D. E. Anderson, *Kansas State University*, *Manhattan*.

Nicotinic acid (niacin) can suppress lipolysis, but responses to dietary niacin have been inconsistent in cattle. Our aim was to determine if a relatively high dose of encapsulated niacin (EN) alters lipid metabolism and productivity of transition cows. Primiparous (n=9) and multiparous (n=13) cows (BCS 3.63 ± 0.08) entered the study 21 days prior to expected calving and were sequentially assigned within parity to EN (24 g/d, provided with ration twice daily) or control treatments through 21 d postpartum. Throughout the study, liver biopsies were collected for triglyceride (TG) analysis and blood samples were collected for nonesterified fatty acid (NEFA) and β-hydroxybutyrate (BHBA) analyses. On d 22-23 postpartum, blood samples were collected every 8 h to monitor post-treatment NEFA responses. Data were analyzed using mixed models with repeated measures over time. There were no prepartum treatment effects on plasma parameters; however, there was a treatment x time x parity effect on prepartum dry matter intake (DMI, $P < 0.07$) caused by a 4 kg/d decrease in DMI of EN-treated cows compared to control cows during the final 5 d prepartum. There were no treatment effects on postpartum DMI. Treatment x time x parity effects were detected for NEFA ($P = 0.09$) and BHBA concentrations ($P = 0.03$) during the postpartum period. Plasma NEFA peaked at 1.7 and 1.3 mEq/L for control heifers and cows, respectively, compared to 0.7 and 0.8 mEq/L for EN-treated heifers and cows. EN treatment also suppressed peak BHBA concentrations in both parity groups. After treatments ended on d 21, there was a treatment x time x parity effect ($P < 0.09$) on plasma NEFA; however, treatment means showed a continued suppression of plasma NEFA by EN in cows, with no evidence of a rebound in either parity group. No treatment effects were observed for liver TG concentration, BCS, BW, or milk or milk component production. These results indicate that a high dose of EN can decrease postpartum plasma NEFA and BHBA, but may also decrease prepartum DMI.

Key Words: niacin, transition, ketosis

585 Effects of low vitamin A and D finishing diets on beef cattle carcass quality. C. L. Pickworth*, S. C. Loerch, and F. L. Fluharty, *The Ohio State University*, *Wooster*.

Vitamins A and D are known to decrease adipocyte differentiation in vitro. It was hypothesized that supplemental vitamin A and D in cattle diets suppress carcass quality. One hundred sixty-eight Angus-based steers (BW = 284 kg) were blocked by BW and allotted to 24 pens. The experiment had a 2x2 factorial arrangement of treatments. Main effects were: 1) no supplemental vitamin A (NA) vs. 3,750 IU/kg of DM supplemental vitamin A (SA) and 2) no supplemental vitamin D (ND) vs. 1,860 IU/kg of DM supplemental vitamin D (SD). The basal diet was 65% high moisture corn, calculated to provide 1,260 IU/kg of DM vitamin A equivalents via beta-carotene, or 60% of the NRC recommendation for feedlot cattle. When the vitamin A and D interaction was not significant (P>0.10) the main effects are presented. Serum and liver vitamin A and D concentrations were greater (P<0.0001) in SA and SD steers on d 184 than NA and ND, respectively. The ND steers were able to synthesize ample vitamin D from sunlight as indicated by no change (P>0.05) in liver concentration of ND steers over time. Subcutaneous and intramuscular fat vitamin A concentrations were lower (P<0.05) in NA than SA steers. Supplemental vitamin D tended (P<0.09) to decrease vitamin A concentration in liver and intramuscular fat. Dry matter intake, average daily gain, and feed efficiency were not affected (P>0.05) by supplemental vitamin A or D. Yield Grades (YG) were higher (P<0.05) for NAND than for other treatments. Backfat thickness (BF) was greater (P<0.05) for steers fed the NAND diet than NASD and SAND fed steers. These results contradict previous results in which YG and BF were not affected by low dietary vitamin A. Hot carcass weight and dressing percent were higher (P<0.05) in NA as compared to SA steers. Marbling scores, Quality Grades and percent grading Average Choice or above were higher (P<0.05) in the NA than the SA treatment, and tended to have higher (P=0.06) ether extracts as well. Carcass quality was not significantly impacted by vitamin D supplementation. In conclusion, NA diets increased total fat deposition and ND had minimal impact on carcass composition of feedlot steers.

Key Words: vitamin A, vitamin D, carcass quality

586 Effects of extended zilpaterol hydrochloride withdrawal on performance, carcass traits, and shear-force value of steaks from finishing heifers. G. L. Parsons*[1], B. E. Depenbusch[1], C. D. Reinhardt[1], D. A. Yates[2], J. P. Hutcheson[2], and J. S. Drouillard[1], [1]*Kansas State University*, *Manhattan*, [2]*Intervet Schering-Plough*, *Desoto, KS*.

Our objective in this study was to determine if extended withdrawal of zilpaterol hydrochloride (Z) would ameliorate negative effects on marbling score and shear force without sacrificing improvement in carcass weight. Crossbred heifers (n = 450; 465 kg ± 27.2) were blocked into heavy and light groups. Within block cattle were stratified by BW and allocated randomly to feedlot pens containing 7 to 10 heifers each, with 9 pens/treatment. Treatments were arranged as a 2 X 3 factorial, with factors consisting of Z fed at 0 or 8.33 g/tonne DM and withdrawal times (W) of 3, 10, or 17 d. Heifers were implanted with Revalor-H and fed flaked corn finishing diets *ad libitum* once daily, providing 300 mg monensin, 90 mg tylosin, and 0.5 mg melengestrol acetate per animal daily. Z was fed for 20 d. With the exception of yield grade, there were no significant ZxW interactions (P > 0.10). For yield grade, ZxW interaction occurred because Z improved USDA yield grade after 3 and 10 d of withdrawal, but no differences were detected by 17 d. Z did not affect DMI, ADG, or gain efficiency (P > 0.10), but increased HCW, dressing percentage, and longissimus muscle area (P < 0.01) and decreased marbling scores (P < 0.01). Z increased HCW by 12.8, 7.7, and 5.2 kg at 3, 10, and 17 d of withdrawal, respectively. Marbling scores were 457, 466, and 459 in control cattle, and 401, 445, and 442 in zilpaterol cattle after 3, 10, and 17 d of withdrawal, respectively. W increased final BW, HCW, and marbling scores (P < 0.04), and decreased back fat and KPH (P < 0.03). Whole loins were collected from 15 randomly selected cattle per treatment in each block and wet aged in vacuum bags for 7, 14, and 21d. Z increased shear force in steaks by 0.54 kg (P < 0.001), but shear force declined linearly with additional aging (P < 0.01), yielding loin steaks with acceptable shear-force after 14 or 21 d of aging.

Key Words: zilpaterol, shear force, performance

587 In vitro evaluation of four bacterial species as potential probiotics in the rumen. T. W. Priambodo, J. Hummel, S. Kehraus, and K.-H. Südekum*, *University of Bonn*, *Bonn, Germany*.

The current study evaluated effects of four potential probiotic bacterial cultures on ruminal in vitro gas production, and on fermentation acid and ammonia concentrations to compare the capability of probiotics and their survival during in vitro ruminal fermentation. Bacterial strains, namely *Lactobacillus buchneri*, *L. brevis*, *Enterococcus faecium* and *Propionibacterium jensenii* were investigated at two different concentrations, namely 10^7 and 10^9 colony forming units (cfu)/ml. The Hohenheim gas test was employed to determine in vitro gas production at 8- and 24-h incubation time, using four different ratios of grass silage to mixed concentrate (dry matter basis; 100:0; 75:25; 50:50; 25:75). The concentrations of ammonium (NH_4^+) and volatile fatty acid (VFA) were determined as well as probiotic cell counts to estimate probiotic activity and persistency. Protozoa were enumerated to estimate the effects of bacterial strains on the rumen fauna. Gas production and individual and total VFA concentrations were affected by probiotic colony concentrations as well as diet type, but only *P. jensenii* at 10^9 cfu/ml increased ($P < 0.05$) gas and VFA production over control values. Probiotic colony counts decreased over the 24-h incubation period, and were least pronounced for *P. jensenii*, indicating that it was the most adaptable strain. Treatments had no ($P > 0.05$) effects on NH_4^+ concentration and protozoal numbers. In general, autoclaved probiotics produced similar concentrations of gas and NH_4^+ as the live probiotics, which likely was a result of fermentation of the carrier material. Only the live *L. brevis* and *P. jensenii* produced more ($P < 0.05$) gas than their autoclaved forms.

Key Words: probiotics, rumen, in vitro

588 Feeding behaviour of wethers fed a temperate pasture with different time of access to food and supplemented or not with additives. A. Pérez-Ruchel[1], J. L. Repetto*[2], M. Michelini[1], L. Pérez[1], G. Soldini[1], and C. Cajarville[1], [1]*Departamento de Nutrición Animal, Facultad de Veterinaria*, *Montevideo, Uruguay*, [2]*Departamento de Bovinos, Facultad de Veterinaria*, *Montevideo, Uruguay*.

The effect of time of access to food (TAF) and supplementation with selected additives on feeding behaviour was studied. Twenty-four wethers were blocked by weight and fed fresh forage (*Lotus corniculatus*, CP 14%), housed in metabolic cages and allocated to 4 treatments. AD animals had access to forage all day (AD); R, RB, RS had forage available 6 h/day. RB and RS were supplemented (2% DMI of 75% NaHCO3-25% MgO and 6.2×10^9 UFC/d of *Saccharomyces cerevisiae*, respectively). Feeding behaviour was recorded for each animal every 3 minutes for 12 h via visual observation by trained operators. Four categories were used to classify animal behaviour: eating, ruminating, drinking and resting. Parameters were compared between treatments by GLM considering 'treatment' and 'block'. Orthogonal contrasts were performed on data to study the effect of TAF, use of additive and the type of additive. Animals with restricted TAF exhibited reduced eating and ruminating time (40% and 36%, respectively) and increased the resting time (47%) in comparison with those fed all day. Animals fed all day masticated 1.6 more times than animals fed 6h/d. The use of additives had no effect on the feeding behaviour. Restricted TAF changed the feeding behaviour of wethers fed forage. *Acknowledgements: PDT-DICyT (78/12 and S/PSP/02/48), CSIC, and CODENOR S.A.*

Table 1.

	Treatments					P contrast		
Cumulative time, min	AD	R	RB	RS	SE	AD vs R + RB + RS	R vs RB + RS	RB vs RS
Eating	328.5	187.5	215.5	194.5	18.1	<.001	ns	ns
Ruminating	169.5	106.0	106.0	114.5	12.6	<.001	ns	ns
Mastication*	498.0	293.5	321.5	309.0	15.4	<.001	ns	ns
Drinking	4.5	4.0	3.0	0.5	1.52	ns	ns	ns
Resting	217.5	422.5	395.5	410.5	15.7	<.001	ns	ns
Ruminating/ resting	0.53	0.66	0.50	0.67	0.12	ns	ns	ns
Mastication/ resting	2.41	0.71	0.83	0.78	0.13	<.001	ns	ns

*: eating + ruminating; SE: standard error; ns: non significant (P>0.05)

Key Words: feeding behaviour, magnesium, *Saccharomyces cerevisiae*

Small Ruminant: Nutrition

589 The effects of replacing alfalfa hay with fresh citrus pulp on ruminal fermentation and ewe performance. J. L. Sparkes, Y. T. E. Fung, I. van Ekris, R. D. Bush, and A. V. Chaves*, *The University of Sydney, Faculty of Veterinary Science*, *Sydney, NSW, Australia*.

Two studies were conducted to determine the effects of replacing alfalfa hay with fresh citrus pulp in Merino ewe diets: (i) an *in vitro* study which measured ruminal fermentation; and (ii) an *in vivo* study in which twelve Merino ewes pre- and post-lambing were fed treatments in a cross-over design over 120 d to evaluate effects on ewe performance (i.e. dry matter (DM) intake (DMI), average daily gain (ADG) and wool growth). In both the *in vitro* and *in vivo* studies, the control treatment consisted (in diet DM) of alfalfa hay (91.3%), lupins (8.3%) and phosphate (0.42%), while the citrus pulp treatment consisted of alfalfa hay (57.7%), lupins (9.5%), phosphate (0.48%) and fresh citrus pulp (32.3%). Data were analyzed with the mixed model procedure of SAS. In the *in vitro* study, gas production, total volatile fatty acid (VFA) yield, proportion of propionic acid to total VFA and *in vitro* dry matter digestibility (IVDMD) were higher (P<0.02) in the citrus pulp treatment compared to the control treatment. In contrast, *in vitro* ammonia production, pH and the acetate to propionate ratio were lower (P<0.03) for the citrus pulp treatment compared to the control treatment. In the *in vivo* study, DMI of ewes fed the citrus pulp diet was lower than their control ewe counterparts throughout both the pre- and post-lambing periods (928.9 vs. 1115.0 g/d pre-; 1285.0 vs. 1620.3 g/d post-lambing, P<0.01), however ADG was similar (P=0.12). Wool growth parameters and lamb performance did not differ (P>0.32) between treatments. In summary, the *in vitro* study demonstrated that the replacement of 30% of an alfalfa diet with fresh citrus pulp improved total VFA yield, increased total gas production and improved IVDMD, while decreasing the production of ammonia, acetic acid and rumen pH. In addition, the *in vivo* study demonstrated that the replacement of 30% of an alfalfa diet with fresh citrus pulp pre- and post-lambing decreased DMI but did not affect a ewe's performance in terms of ADG and wool growth. These findings would be of significant interest to producers endeavoring to control feed cost while maintaining productivity.

Key Words: in vitro, Merino sheep, wool growth