drench, either via oral or ruminal drench. Production of total VFA however was not statistically altered by PG. Serum insulin peaked significantly higher and more rapidly for cows receiving PG via drenching but not as a part of the TMR. Plasma glucose, however, tended to peak higher and more rapidly for cows receiving PG, regardless of delivery method. Results showed that rumen and blood metabolites responded similarly to liquid or dry PG drench indicating that top dressing dry PG is as effective as oral drenching liquid PG. Feeding dry PG as a part of the TMR during frequent feeding significantly altered the rumen profile toward a more glucogenic environment without stimulation of insulin.

909 Glucose minimal modeling in lactating dairy cows. R. C. Boston*[1], J. R. Roche[2], and P. J. Moate[1], [1]*University of Pennsylvania*, *Kennett Square*, [2]*University of Tasmania*, *Burnie, Tas, Australia*.

Quantification of the kinetics of glucose metabolism in lactating dairy cows may have application in elucidating the factors that control milk production or are involved in the etiology of metabolic diseases such as ketosis, fatty liver disease and downer-cow syndrome. For more than twenty years, researchers in the field of diabetes have used the Intravenous Glucose Tolerance Test (IVGTT) in humans, coupled with Bergman's non-linear "minimal model" (MinMod) to derive a rich set of parameters to describe the interaction between blood glucose and insulin. These parameters include: Glucose effectiveness (S_g), a first order rate constant describing its disappearance from blood, and Insulin sensitivity (S_I), which represents the capacity of insulin to promote the disposal of glucose from blood. Although more than 700 publications in human research have used the well-documented and carefully standardized IVGTT protocol and minimal modeling methodology, few studies in ruminant nutrition have used this approach. This investigation examined the capability of the standard (no insulin injection) IVGTT coupled with minimal modeling to obtain identified estimates of S_g and S_I in lactating cows. Ten lactating cows of diverse genetic origin and fed a wide range of diets, underwent a standard IVGTT with blood sampled at 0, 2, 4, 6, 8, 10, 12, 15, 18, 20, 23, 26, 30, 35, 40, 50, 60, 90, 120, 150, 180, 210, and 240 minutes. Plasma was measured for glucose and insulin. Minimal model analysis was conducted using MINMOD Millennium. The median, minimum and maximum estimates for S_g [% min^{-1}] were: 2.25, 1.12 and 3.44 and for S_I [10^{-4}(mU/L)$^{-1}$.min^{-1}], the corresponding estimates were 12.9, 8.7 and 17.1. In all individual cows, S_g and S_I were well identified with coefficients of variations less than 5%. The median estimate 2.25 for S_g is similar to the value of 2.2 reported for humans, but the median value of 12.9 for S_I in cows is surprisingly substantially higher than the value of 2.0 in humans. These findings suggest that glucose minimal modeling has great potential application in ruminant nutrition research.

Key Words: Glucose Effectiveness, Insulin Sensitivity, Minimal Model

Ruminant Nutrition: Lipid Supplementation

910 A decade of research developments in ruminant nutrition at the University of Wyoming. B. W. Hess*, *University of Wyoming*, *Laramie*.

Research efforts have focused on nutritional management practices to improve production efficiency of forage–fed ruminant animals, with primary emphasis on strategic supplementation regimens and secondary interest in alternative forage systems. The research program consists of three primary foci: 1) dietary lipids for ruminant animals; 2) protein nutrition of ruminant animals; and 3) the use of alternative forage crops and cropping methods in ruminant animal production systems. Interest in dietary lipids stems from the potential to alter fatty acid composition of food products derived from ruminants and the possibility to increase reproductive performance of ruminants through provision of supplemental vegetable oil. Investigations span from evaluating effects of supplemental lipids on site and extent of digestion to characterizing fate of fatty acids during metabolism and subsequent responses within various tissues and by the whole animal. Results of those endeavors suggest that vegetable oil may be added to forage–based diets at 3% of total DMI, tissue composition of fatty acids generally reflect fatty acids made available to the animal after ruminal biohydrogenation, and feeding cracked high–linoleate safflower seeds to beef cows during early lactation may have deleterious effects on reproduction and immune response by the suckling calf. The likelihood of livestock experiencing limited DMI in many range production systems has led to exploration of range management practices to enhance rangeland forage productivity and quality. Additionally, an interest in identifying specific nutrients involved with mediating various physiological responses within the animal has led to investigations centered on assessing essential AA status in ruminants fed limited amounts of roughage. An animal protein–based supplement has been developed to balance intestinal supply of essential AA in ruminants fed limited amounts of roughage. The research program is becoming more integrated as nutritional evaluations of rangeland forages indicate that strategic supplementation with lipids or protein may be warranted.

Key Words: Forages, Ruminants, Supplementation

911 Effect of dietary fish and soyoil supplementation on muscle fatty acid concentrations and oxidative lipid stability in beef cattle. D. A. Kenny*[1], J. P. Kelly[1], F. J. Monahan[1], and A. P. Moloney[2], [1]*University College Dublin*, *Dublin 4, Ireland*, [2]*Teagasc Grange Research Centre*, *Co. Meath, Ireland*.

The objective of this study was to examine level and duration of soyoil (SO) and fishoil (FO) supplementation on muscle fatty acid (FA) concentration and lipid oxidative stability in beef cattle. Young beef bulls (n=48) were blocked on age, bodyweight, and breed and individually offered ad libitum one of four isolipid and isonitrogenous diets for 100 days. All diets consisted of 10:90 (DM basis) straw:concentrate. The concentrates contained one of: (i) 6% SO (CON); (ii) 6% SO + 1% FO (FO1); (iii) 6% SO + 2% FO (FO2) or (iv) 8% palmitic acid for first 50 days and 6% SO + 2% FO for latter 50 days (FO2(50)). Palmitic acid was added to CON and FO1 to give 8% added lipid. The SO had 53% linoleic acid while the FO had 39%

EPA and 24% DHA. All diets were fortified with vitamin E. Following slaughter steaks were recovered from the M. longissimus dorsi (LD) and FA were analysed by GC. Lipid oxidative stability of LD was measured at 0, 24, and 72 h post cooking. The data were analysed using mixed models ANOVA with repeated measures as appropriate. Muscle concentrations of EPA and DHA were not different within FO treatments but were higher ($P < 0.001$) in all FO treatments compared with CON. Vaccenic acid (VA) the substrate for Δ-9 desaturase catalysed synthesis of c9, t11 CLA was higher in FO1 and FO2 compared with CON ($P < 0.01$) or FO2(50) ($P< 0.05$) but there was no difference ($P > 0.05$) between FO2(50) and CON. There was no effect ($P > 0.05$) of treatment on the concentration of c9, t11 CLA. The t10 c12 CLA isomer was higher in FO2 compared with the other treatments ($P < 0.05$). After 24 and 72 h post cooking, malondialdehyde (MDA) concentrations in CON were lower compared with the three fishoil treatments ($P < 0.01$). There was a tendency towards higher MDA in FO2 compared with FO1 at both 24 and 72h ($P = 0.08$). The lack of enhancement in c9, t11 CLA despite increases in tissue VA, suggest a possible direct inhibitory effect of ω-3 PUFA on Δ-9 desaturase activity. Furthermore, increasing ω-3 PUFA in the animals diet tended to reduce the oxidative stability of beef post cooking.

Key Words: Beef Cattle, CLA, Fatty Acids

912 Effects of feeding fresh and oxidized fat in the presence and absence of dietary antioxidant on lactation performance. M. Vazquez-Anon[1], G. Bowman*[1], T Hampton[1], P. Vazquez[2], T. Jenkins[3], and J. Nocek[4], [1]*Novus International*, *St Charles, MO*, [2]*Universidad de Santiago*, *Lugo, Spain*, [3]*Clemson University*, *Clemson, SC*, [4]*Spruce Haven Research*, *Union Springs, NY*.

The objective of the study was to evaluate the effect of feeding the dietary antioxidant AGRADO Plus® (AO; Novus International) in diets that contained 2 % fresh (FF) or oxidized (OF) soybean oil on milk production and composition and plasma antioxidant status of cows. Forty-four mid-late lactating primiparous cows were housed in a tie-stall barn and fed a diet that contained 2% FF for 15 days as adaptation period and them randomly allocated to the four dietary treatments (FF, FF+AO, OF, OF +AO) for six weeks. Feeding AO improved dry matter intake 3% ($P = 0.007$), milk yield 2.7% ($P = 0.08$), fat corrected milk 3.8% ($P = 0.01$), and milk fat yield 5.3% ($P = 0.01$). Feeding OF reduced dry matter intake 2.2% ($P = 0.04$) and BW at the end of the trial ($P = 0.05$) and increased milk fat yield 5.3% ($P = 0.02$). Feeding AO improved plasma total antioxidant status (TAS; $P = 0.002$) and the activity of antioxidant enzyme glutathione peroxidase ($P = 0.009$), whereas, feeding OF reduced TAS ($P = 0.003$) and increased accumulation of end products of oxidation in plasma ($P = 0.003$) at the end of the trial. It can be concluded that feeding OF reduced dry matter intake, BW, and the antioxidant status of the cow but improved milk fat yield. Feeding AO improved dry matter intake, milk yield and fat and the antioxidant capacity of the animal, independently of the degree of oxidation of the dietary fat.

Key Words: Antioxidants, Oxidized Fat, Agrado

913 The energetic and non–energetic effects of supplemental fish oil during the peripartum period on the metabolic status of multiparous Holstein cows. M. A. Ballou*, M. K. Yelle, R. C. Gomes, D. W. Kim, and E. J. DePeters, *University of California*, *Davis*.

The etiology of ketoacidosis and hepatic lipidosis during the peripartum period is complex. Increased energy demands and shifts in the hormonal and cytokine milieu play a role. In addition to its energy component, fish oil was shown to repress inflammation and alter gene expression profiles. The objectives were to evaluate the energetic and non–energetic effects of supplemental fish oil during the peripartum period on the metabolic status of multiparous cows. 42 Holstein cows were completely randomized to one of three treatments at 3 wk prepartum. Treatments were no supplemental lipid or supplemental lipid at either 250 g (prepartum) or 1% of the previous day's intake (postpartum), from either Energy Booster®(EB) or fish oil (FO). Supplemental lipid was fed as a bolus prior to the AM feeding. DMI was recorded daily; BW and BCS were measured at d -21, +1, +10, and +21. Peripheral blood samples were collected 3X weekly until 21 DIM. On d -21, -10, +1, and +14 a liver biopsy was performed to determine the FA, triglyceride, and glycogen concentration in the liver. Feed intake during the pre- and postpartum periods was not affected by either supplementing the diet with lipid or the source of lipid. Cows fed either lipid source lost similar BW and BCS during the peripartum period. Supplemental lipid had no effect on prepartum serum glucose concentrations, but postpartum glucose was higher for EB and FO compared with control (49.7, 50.7, 47.3 mg/dl; $P<0.05$) respectively. Serum NEFA concentration was lower in EB and FO both prepartum (0.28, 0.25, 0.50 mM; $P<0.02$) and postpartum (1.04, 0.88, 1.17 mM; $P<0.05$). Serum BHBA concentration was unchanged prepartum, but was lower in lipid supplemented cows postpartum (1.30, 1.25, 1.88 mM; $P<0.001$). There was no effect of either lipid or source on liver glycogen composition. Supplementing FO did not adversely affect intake; subsequently these cows had metabolic profiles that indicated better energy status. However, the effects of FO appear to be predominately due to the direct effects on energy intake rather than any non-energetic effects.

Key Words: Transition, Fish Oil, Metabolism

914 Lactation response and milk α-linolenic acid concentration in dairy goats fed different forage species supplemented with extruded linseed. A. Doyon*[1], G. F. Tremblay[2], D. Cinq–Mars[3], and P. Y. Chouinard[1], [1]*Nutraceuticals and Functional Foods Institute (INAF), Laval University*, *Quebec, QC, Canada*, [2]*Agriculture and Agri-Food Canada, Soils and Crops Research and Development Center*, *Quebec, QC, Canada*, [3]*Ministère de l'Agriculture, des Pêcheries et de l'Alimentation du Québec, Direction de l'innovation scientifique et technologique*, *Quebec, QC, Canada*.

Forages and linseed are two important sources of lipids in the diets of ruminant animals. The objective of this study was to evaluate the effect of forage species and extruded linseed supplementation on milk production and composition in dairy goats. Thirty six primiparous Alpine dairy goats (90 days in milk; 48 kg body weight) were randomly assigned to 6 dietary treatments within a 3×2 factorial arrangement in a 4 week experiment. Treatments were three forage species (corn, alfalfa, and annual ryegrass silages) fed at 60% of dry matter in a TMR supplemented with 0 or 17% extruded linseed (EL). Diets were

formulated to be isonitrogenous, and goats were allowed ad libitum consumption. Treatment differences were compared at week 4 with data from week 0 used as covariates. Alpha-linolenic acid (*cis*-9, *cis*-12, *cis*-15 C18:3) concentration in TMR was 2.0, 8.8, 16.0, 43.8, 56.8, and 60.6 mg/g DM for corn, alfalfa, ryegrass, corn+EL, alfalfa+EL, and ryegrass+EL, respectively. Dry matter intake, milk yield, protein yield, true protein yield, and casein yield were lower, and milk fat content was higher when goats were EL supplemented as compared to nonsupplemented rations ($P<0.01$). Goats fed alfalfa had a higher milk fat content compared to those fed corn or ryegrass ($P<0.01$), and a higher milk fat yield compared to goats fed corn silage ($P<0.01$). The milk fat concentration (mg/g of FA) of α-linolenic acid was increased by the EL supplement ($P<0.01$), and this increase was more pronounced ($P<0.05$) with corn (3.4^{d} vs. 17.2^{a}), intermediate with alfalfa (8.8^{c} vs. 16.4^{a}), and lower with ryegrass (11.1^{b} vs. 17.2^{a}) silage. In conclusion, the concentration of omega-3 fatty acids in milk of dairy goats can be increased by feeding forage species rich in α-linolenic acid and it can be further increased by supplementation with EL.

Key Words: Milk Fatty Acids, Omega-3 Fatty Acids, Forage Fatty Acids

915 Predicting production of de novo fatty acids in milk. P. J. Moate*[1], W. Chalupa[1], R. C. Boston[1], and I. J. Lean[2], [1]*University of Pennsylvania*, *Kennett Square, PA*, [2]*Sydney University*, *Sydney, NSW, Australia*.

We have developed a model to describe effects of diet and cow factors on milk fat concentration and concentrations of individual long chain fatty acids (LCFA) in milk. We collated data on milk from 120 treatment groups of cows described in 29 published dietary experiments. The diets included a wide variety of fat supplements and wide range in fatty acid intakes (258 - 1794 g/d). Mixed effects modeling was used to relate dietary and cow factors to total production of C4-C15 fatty acids (TPdenovo) [g/d]. The regression equation which best described TPdenovo was:

$$TPdenovo = 190 \pm 41 + 24.8 \pm 4.42^{*} IFCHO - 1.01 \pm 0.163^{*}ATuFA + 0.0018 \pm 0.0004^{*}ATuFA^{2} - 0.25 \pm 0.029^{*}IFishFA - 21.2 \pm 10.7^{*}Diet - 6.46 \pm 2.20^{*}DIM^{0.5}$$

Where IFCHO (kgDM/d) represents intake of fermentable carbohydrate, ATuFA (g/d) is the estimated (by CPM-Dairy) amount of unsaturated fatty acids absorbed from the diet, IFishFA (g/d) is the intake of fish-oil fatty acids, Diet is a categorical variable (0 = Pasture diet, 1 = TMR) and DIM is days in milk. The R^2 for this regression was 0.76 and the RMSE was 37.4 (g/d). Milk fatty acids containing 4 to 15 carbon atoms and approximately half of the C16 fatty acids are generally considered to be synthesized de novo in the udder. Univariate regressions revealed strong linear relationships between the total production of de novo fatty acids and production of individual de novo fatty acids. The slope coefficients for these regressions indicate that each of the individual fatty acids constitute a fairly fixed proportion of the total production of de novo fatty acids. The estimated coefficients (± SE) were: C4:0 0.12 ± 0.01; C6:0 0.082 ± 0.004 ; C8:0 0.052 ± 0.003 ; C10:0 0.111 ± 0.003; C12:0 0.134 ± 0.004; C14:0 0.441 ± 0.007; C14:1 0.046 ± 0.002; and for C15:0 0.043 ± 0.002. These findings present a simple method to predict daily production of individual de novo fatty acids.

Key Words: Model, Predict, de Novo Fatty Acids

916 Effect of in vitro DHA supplementation to adapted and non-adapted rumen inoculum on the biohydrogenation of linolenic and linoleic acid. B. Vlaeminck[1], G Mengistu[2], J. Dijkstra[2], and V. Fievez*[1], [1]*Laboratory for Animal Nutrition and Animal Product Quality*, *Ghent University, Belgium*, [2]*Animal Nutrition Group*, *Wageningen University, The Netherlands*.

The objective was to examine the ruminal biohydrogenation of linoleic (C18:2 n-6) and linolenic (C18:3 n-3) acid during in vitro incubations with rumen inoculum from dairy cattle adapted or not to DHA and either with or without additional DHA supplementation in vitro. Treatments were incubated in 100 ml flasks containing 400 mg freeze dried grass, 5 ml strained ruminal fluid and 20 ml phosphate buffer. Ruminal fluid was collected just before the morning feeding from three cows receiving a control diet (49% ryegrass silage, 39% corn silage, 1% straw and 11% concentrate, fresh weight basis) supplemented with marine algae for 21d (DHA-adapted population, Adapt) or from the same cows receiving the control diet only (non-adapted population, non-Adapt). In half of the incubation flasks, pure DHA (5mg) was added as an oil-ethanol solution (100 µl). Incubations were carried out during 0, 0.5, 1, 2, 4, 6 and 24h. After 24h, in vitro addition of DHA resulted in higher amounts (mg/incubation) of C18:3 n-3 (0.23, 0.43, 0.26 and 0.34 for Adapt, Adapt+DHA, non-Adapt and non-Adapt+DHA, respectively, SEM=0.047), C18:2 n-6 (0.14, 0.22, 0.15 and 0.20, SEM=0.071) and trans-11, cis-15 C18:2 (0.27, 2.40, 0.06 and 2.20, SEM=0.220) whereas no effect of inoculum source was observed. Trans-11 C18:1 accumulated after 24h when Adapt was incubated irrespective of DHA supplementation, whereas in incubations with non-Adapt, accumulation of trans-11 C18:1 only occurred when DHA was added (6.40, 4.35, 1.06 and 3.91, SEM=0.047). The increased amounts of trans-11 C18:1 was due to the strong inhibition of the reduction to C18:0. Indeed, after 24h, the amount of C18:0 was significantly different from 0h for the non-Adapt treatment without in vitro DHA only (0.49, 0.34, 8.95 and 2.14, SEM=0.369). The results show the DHA-adapted microbial population is able to convert trans-11, cis-15 C18:2 but not trans-11 C18:1 whereas DHA inhibits the conversion of both trans-11, cis-15 C18:2 and trans-11 C18:1.

Key Words: Biohydrogenation, DHA, Rumen

917 Identification of enriched conjugated linoleic acid isomers in cultures of ruminal microorganisms after dosing with 1-^{13}C-linoleic acid. Y-J. Lee*[1], J. T. Brenna[2], P. Lawrence[2], S. K. Duckett[1], G. L Powell[1], W. C. Bridges, Jr.[1], and T. C. Jenkins[1], [1]*Clemson University*, *Clemson, SC*, [2]*Cornell University*, *Ithaca, NY*.

Most accounts of linoleic acid biohydrogenation depict its conversion to only a single conjugated linoleic acid (CLA) isomer (c9t11). A multitude of other CLA isomers have been identified in ruminal contents, raising questions that the pathway of linoleic acid biohydrogenation is more complex. The objective of this experiment was to identify CLA isomers that arise from ruminal biohydrogenation of linoleic acid. Six rumen in vitro cultures were run that contained ground dairy feed (with 5% added unsaturated fatty acids), buffer, and strained rumen fluid from a ruminally-fistulated dairy cow. Half of the cultures received an additional 50 mg of unlabelled linoleic acid in 1 mL of ethanol and the other half received a mixture of 15 mg 1-^{13}C-linoleic acid and 35 mg unlabelled linoleic acid in ethanol injected at the start of incubation. Samples were taken from each flask at 0, 24, and 48 hours. Methyl esters of fatty acids were separated on a 100-m CP-Sil 88 column and abundances of the quasimolecular ion (M) and M+1 ion were

determined by mass spectroscopy in positive chemical ionization mode using methane reagent gas. Geometry and double bond position of CLA isomers was verified by acetonitrile chemical ionization tandem mass spectrometry. Enrichment for each peak was calculated as [(M+1/M) * 100] in labeled minus unlabelled cultures and tested for their difference from zero by t-test ($P < 0.05$). At 48 h of incubation, enrichment was observed in t11 18:1 (14.2%), 18:0 (2.7%), and seven CLA isomers (range from 18.1 to 30.7%). The c9t11 isomer had the highest enrichment (30.7%), followed by enrichments from 20.8 to 23.4% for t10c12, c10t12, t9t11, and t10t12. The remaining two CLA isomers (c9c11 and c10c12) had enrichments of 18.1 and 19.2%, respectively. The results of this study verified the formation of c9t11 and t10c12 CLA isomers from linoleic acid biohydrogenation. An additional five CLA isomers also contained carbons that originated from linoleic acid indicating that pathways of linoleic acid biohydrogenation are more complex than usually depicted.

Key Words: Linoleic Acid, Biohydrogenation, Conjugated Linoleic Acid

918 Octadeca-carbon fatty acids affect microbial fermentation, methanogenesis and microbial flora in vitro. C. M. Zhang*[1], J. X. Liu[1], Y. Q. Guo[1], Z. P. Yuan[1], J. K. Wang[1], and W. Y. Zhu[2], [1]*College of Animal Sciences, Ministry of Education Key Laboratory of Molecular Animal Nutrition, Zhejiang University*, *Hangzhou, Zhejiang, P.R. China*, [2]*College of Animal Science and Technology, Nanjing Agricultural University*, *Nanjing, Jiangsu, P.R. China*.

The effects of type and level of C18-fatty acids on rumen fermentation, methane emission and microbial community structure were examined using an in vitro gas production technique (Reading Pressure Technique). Three levels (0, 3.5 and 7.0% of substrate DM) were evaluated for four types of C18-fatty acids: stearic acid, oleic acid, linoleic acid and linolenic acid. The 24 h gas production and methane emission were significantly decreased by type, level and their interactions ($P<0.001$). Methane suppressing effect of unsaturated C18-fatty acids was more profound than on gas production. Compared to the control, addition of C18-fatty acids had little effect on pH, concentration of ammonia-N and total volatile fatty acids. However, the fermentation patterns were significantly changed ($P<0.001$), with lower proportion of acetate and higher propionate with increasing levels and unsaturation of C18-fatty acids. Methanogens and protozoa population relative to total bacteria were decreased by linoleic and linolenic acids, with the linolenic acid being more effective. However, addition of these unsaturated C18-fatty acids also inhibited growth of fibrolytic microbes including fungi, *F. succnogens* and *R. flavefaciens*. From the present study, it is demonstrated that there is a significant effect of unsaturated C18-fatty acids on suppressing methanogenesis, mediated probably by a direct action against the rumen microbes involved in methane formation and by a decreased hydrogen supply.

Key Words: C18-Fatty Acids, Methane Emission, Microbial flora

919 Effect of feeding rate of a 26% CP calf milk replacer. T. M. Hill*, H. G. Bateman, II, J. M. Aldrich, and R. L. Schotterbeck, *Akey*, *Lewisburg, OH*.

The objective was to determine the effect of feeding rate of a 26% CP, 17% fat milk replacer (MR) on calf ADG, starter intake, and efficiency. Single source Holstein calves (d 0 = 42 ± 2 kg, 3-4 d old) were fed different amounts of the MR and weaned on d 42. They were offered free-choice water and 18% CP starter in individual pens within a naturally ventilated barn with no supplemental heat. In Trial 1, MR (16 calves/MR) were fed at A) 681 g/d, B) increased to 795 g/d by day 8, or C) increased to 908 g/d by d 15. In Trial 2, MR (24 calves/MR) were fed at A) 681 g/d or C) increased to 908 g/d by d 14. In Trials 1 and 2, calves were weaned by feeding half of the MR amount on d 39-42. In Trial 3, the MR (24 calves/MR) were fed at A) 681 g/d or D) increased to 1,135 g/d by day 22. Calves were weaned by feeding half of MR A on d 39-42 or half of MR D on d 36-42, in Trial 3. In Trials 1-3, post-weaning measurements were made in the individual pens until d 56 and no calf rejected any MR fed. Each trial was analyzed as a randomized block design. In each trial, calves fed MR A grew the slowest ($P < 0.05$) during d 1-21. In Trial 1, starter intake and efficiency from 0-42 d declined linearly as MR increased ($P < 0.05$), while ADG did not differ from 0-42, 42-56, and 0-56 d. In Trial 2, calves fed MR A had the slowest ADG, were least efficient, and consumed the most starter from 0-42 d and had the fastest ADG, were most efficient, and consumed the most starter from 42-56 d ($P < 0.05$). The ADG from 0-56 d did not differ between MR. In Trial 3, calves fed MR A had the slowest ADG, were least efficient, and consumed the most starter from 0-42 d and had the fastest ADG, were most efficient, and consumed the most starter from 42-56 ($P < 0.05$). The ADG from 0-56 d did not differ between MR. In summary, calf ADG from 0-56 d was not improved when the 26% CP MR was fed at more than 681 g/d because starter intake and efficiency was decreased at higher feeding rates.

Key Words: Calves, Milk Replacer

920 Effect of CP concentration in a post-weaning calf grower. T. M. Hill*, H. G. Bateman, II, J. M. Aldrich, and R. L. Schotterbeck, *Akey*, *Lewisburg, OH*.

The objective was to determine to the effect of CP concentration in the diet for weaned calves. The four treatments were A) 13.5, B) 15.0, C) 16.5, and D) 18.0% CP (as-fed basis). Each feed contained 3% molasses, 12.5% pellet (34% CP, minerals, vitamins), and 25% whole oats. Rolled corn and a 40% CP pellet (77.7% soybean meal, 12.8% wheat midds, 5% alfalfa meal, 3% binder, 1.5% fat) were varied to achieve the targeted CP concentration. The feeds (blended with 5% chopped grass hay, 14% CP as-fed) and water were fed free-choice. Single source Holstein steers (d 0 = 81 ± 2 kg, 59-60 d old) that had been weaned 28 d from a 26% CP, 17% fat MR fed at 0.68 kg/d were used. Calves were fed for 28 d in pens (4 pens/treatment, 6 calves/pen). Calves were weighed, hip widths and body condition were measured on d 0 and 28. Feed offered and refused was measured daily. Venous blood of calves from 2 pens/treatment) were also sampled on d 0 (baseline values), 7 and 28 and analyzed for several constituents. The change in blood constituent from d 0 was calculated. Performance measures (as a randomized block design) and blood measures (as a completely randomized design) were analyzed with pen being the experimental unit using polynomial contrast statements to characterize the treatments. Body weight gain (A= 0.99, B= 1.09, C= 1.11, D= 1.11, SEM= 0.02 kg/d), efficiency (A= 0.33, B= 0.36, C= 0.36, D= 0.35, SEM= 0.009 gain/feed), and change in hip width (A= 2.0, B= 2.2, C= 2.2, D= 2.2, SEM= 0.07 cm) increased quadratically ($P < 0.05$) to concentration of CP in the diet with calves fed A being lowest. The change in serum urea nitrogen (A= -2.7, B= -1.3, C= -0.8, D=

-0.6, SEM= 0.2 mmol/L) and creatinine (A= +11.3, B= -7.3, C= -5.8, D= -7.2, SEM= 3.5 umol/L) concentration from d 0-28 increased in a quadratic ($P < 0.05$) manner as CP concentration of the diet increased. These results indicated that 13.5% CP diets were deficient, 15% CP diets were marginal, and 16.5 and 18% CP diets were adequate for calves 2-3 months of age.

Key Words: Calves, Protein

Sheep Species: Sheep Production and Management

921 Cobalt supplementation to the pregnant ewe reduces vitamin E levels in the newborn lamb. T. M. Boland*, L. Hayes, J. J. Murphy, T. Sweeney, J. J. Callan, and T. F. Crosby, *University College Dublin*, *Belfield, Dublin 4, Ireland*.

The objective of this experiment was to determine the effects of offering supplementary iodine or cobalt during late pregnancy on lamb serum vitamin E and IgG concentrations at 24 and 72 h *post partum*. Sixty twin-bearing ewes were individually penned and offered grass silage *ad libitum* supplemented with 800g/ewe daily of a 190g/kg crude protein concentrate, with or without supplemental cobalt or iodine, from day 126 of gestation until parturition. Ewes were allocated to one of the following treatments: **C:** no mineral supplement; **I-3:** 26.6 mg iodine from day 126 – parturition; **I-1:** 26.6 mg iodine from day 138 – parturition; **Co-3:** 20 mg cobalt from day 126 – parturition. Colostrum yield was measured following hand milking at 1, 10 and 18 h *post partum*, after which the lambs were fed measured quantities of colostrum, via stomach tube. A 10 ml blood sample was taken from lambs at 24 and 72 h *post partum* for IgG and vitamin E determination. The efficiency of IgG absorption at 24 h *post partum* was lower in the progeny of ewes offered supplementary iodine for either one or three weeks (I-3; 0.08, I-1; 0.18) than in the progeny of the ewes not offered supplementary iodine (C; 0.26, Co-3; 0.28; $P < 0.001$) resulting in reduced IgG concentrations at both 24 and 72 h *post partum* ($P < 0.001$) in the lamb's serum. Lamb serum vitamin E concentration was lower for both of the iodine supplemented treatments than for Co-3 at 24 h *post partum* (2.02, 2.06 v. 2.48; sem 0.137), while at 72 h *post partum* the lamb serum for all mineral supplemented treatments (I-3, I-1 and Co-3) had lower vitamin E levels than in the control (C) lambs ($P < 0.01$). We conclude that not only do excessively high levels of dietary iodine in late pregnancy lead to a reduction in IgG and vitamin E transfer but that excessively high dietary cobalt in late pregnancy (20 mg per ewe per day) also leads to a breakdown in the transfer of vitamin E from colostrum to the serum of the newborn lamb.

Key Words: Cobalt, Iodine, Vitamin E

922 Evaluation of alternative small ruminant finishing systems for the tropics. S. A. Weiss*, R. C. Ketring, and R. W. Godfrey, *University of the Virgin Islands, St. Croix*, *Kingshill*.

The objective of the experiment was to evaluate the growth and carcass characteristics of Dorper $/times; St. Croix White lambs managed in two types of post-weaning alternative pasture finishing systems in the tropics. After weaning and background grazing on native pasture for eight months, lambs (n = 37) were stratified by weight and sex into two treatments consisting of native pasture (NP) and improved pasture (IP), with energy supplement. Native pasture consisted of a mix of guinea grass (Panicum maximum) and hurricane grass (Boithrocloa pertusa), while IP consisted of a mix of seeded tropical legumes (Desmanthus vergatus, clitoria ternetea, and Lablab purpureus) and volunteer guinea grass. All lambs were supplemented with crushed corn daily at 1% of BW for 100 d and slaughtered at approximately 365 d of age. During the finishing trial, IP lambs had greater total weight gain ($P < 0.0001$) than NP lambs (10.8 vs. 6.8 ± 0.6 kg, respectively). In addition, IP lambs had higher ADG ($P < 0.0001$) than NP lambs (112.2 vs. 66.5 ± 5.9 g/d, respectively). Compared to NP lambs, IP lambs were heavier at slaughter ($P < 0.0001$; 37.8 vs. 32.4 ± 0.9 kg, respectively), had heavier carcasses ($P <0.0001$; 18.7 vs. 15.1 ± 0.6 kg, respectively), and greater dressing percentages ($P = 0.0633$; 49.5 vs. 46.7 ± 1.1%, respectively). Further, IP lambs had greater leg circumference ($P < 0.0005$; 43.4 vs. 40.1 ± 0.6 cm, respectively), body wall thickness ($P < 0.0001$; 14.8 vs. 9.6 ± 0.7, mm, respectively), and rib eye area ($P <0.0001$; 12.9 vs. 10.1 ± 0.4 cm^2, respectively) than NP lambs. Back fat thickness for IP and NP lambs was 3.1 and 2.1 ± 0.3 mm, respectively ($P < 0.02$). The IP lambs had greater percent KPH ($P < 0.02$) than NP lambs (3.8 vs. 3.1 ± 0.2%, respectively). In this study, crossbred hair sheep lambs grown under tropical conditions responded with improved growth rate and carcass muscularity to mixed legume improved pasture but had similar yield grades compared to lambs grown on native pasture.

Key Words: Sheep, Legumes, Pasture Finishing

923 Potential for onions to reduce bitterweed toxicity in sheep. E. S. Campbell*[1], T. R. Whitney[2], C. A. Taylor[1], and N. Garza[1], [1]*Texas Agricultural Experiment Station*, *Sonora, TX*, [2]*Texas Agricultural Experiment Station*, *San Angelo, TX*.

Bitterweed (*Hymenoxys odorata*) toxicity is a major cause of death losses in sheep. Supplements high in sulfhydryl groups (i.e. L-cysteine) can be used to prevent bitterweed intoxication. Cull onions (*Allium cepa*) are an inexpensive and commercially available feed source that also contain high levels of naturally occurring disulfide compounds. Yearling Rambouillet (n = 12; 22.9 kg BW) and Dorper $/times; Barbado (Dorpado) ram lambs (n = 12; 22.5 kg BW) were used to evaluate whether onions have the potential to reduce bitterweed toxicity in sheep. Each breed was randomly assigned to one of four groups: no onions, 25% onions, 50% onions, and 75% onions (DM basis). The remainder of the isonitrogenous diet consisted of alfalfa pellets to provide 43 g DM/kg BW per d. The study was divided into three periods. Period 1 represented control data, prior to onion and bitterweed challenge. In period 2, lambs were incrementally adapted to respective onion diets for 14 d. In period 3 lambs were dosed with an aqueous slurry of dried bitterweed (0.25% live weight) for five days. At the end of each period blood samples were analyzed for serum chemistry measurements. Hematocrits, overall DMI and feed refusals were also measured. The statistical model included breed, onion level, and the two-way interaction. Following period 3 there was a breed effect ($P < 0.05$) for serum measurements reflective of bitterweed