Student Research Abstracts

Effect of Ewe Body Condition During Mid to Late Gestation on Mammary Composition of Female Progeny

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The foundation for functional mammary secretory tissue, parenchyma (**PAR**), is established early in life; amount of PAR directly relates to future milk production. Dam body condition score (**BCS**) during mid to late gestation may affect progeny postnatal mammary composition via in utero metabolic programming events. Pregnant ewes (n = 96; ~80 days of gestation) were allotted to treatment groups based on initial BCS of 2, 3, or 4 (on a 1 to 5 scoring system with 1 being extremely thin and 5 being extremely fat). Ewes were housed in 18 pens (6 pens per treatment) and fed a maintenance diet of limit-fed corn silage (2.42 lb/day DMI), to which whole shelled corn was supplemented at 0.26, 0.57, and 1.03 lb.day DMI for BCS groups 2, 3, and 4, respectively. Diets were adjusted every 2 wk to maintain initial BCS throughout pregnancy. Prior to weaning, lambs nursed their mothers and were fed a common starter. Lambs were weaned (~56 days of age; 51.9 lb) and placed on a common finishing diet that met NRC requirements. Female progeny from the 3 BCS groups (n = 73) were slaughtered at similar BW (103 ± 1.1 lb; $P = 0.913$), and age (126.3 ± 2.8 days; $P = 0.159$). Udders were removed and mammary tissue subjected to biochemical analysis. Total mammary gland weights (179, 167, and 176 ± 8.8 g for BCS 2, 3, 4, respectively) did not differ by treatment ($P = 0.615$). However, PAR weight of progeny from BCS 2 ewes (25.3 g) was greater ($P = 0.074$) than that of BCS 3 (18.5 g) or BCS 4 (18.8 g ± 2.38 g) progeny. Protein mass within PAR of BCS 2 progeny (1.43 g) was greater ($P = 0.053$) than that of BCS 3 (1.02 g) or BCS 4 progeny (1.07 ± 0.13 g). The same was true for DNA mass within PAR (BCS 2 = 134.8, 3 = 93.1, and 4 = 103.0 ± 13.4 mg; $P = 0.072$). Lipid mass within PAR did not differ by treatment and averaged 7.10 ± 1.17 g ($P = 0.228$). Despite detectable differences in PAR due to treatment, no differences in weight or composition of the mammary fat pad were found. Factors that promote mammary PAR growth may have a positive impact on future milk production. Our observations suggest that BCS during gestation may have important lactation performance implications for female progeny.

Evaluation of Dry Hay and Baleage for Transitioning Post-Weaned, Prepubertal Dairy Heifers to Higher Forage Diets

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Dairy heifers often undergo rapid diet changes as they transition from the post-weaned phase to the growing phase, and little information is available as to the effect of feeding baleage during this time period. The objective of this study was to evaluate the effects of feeding dry hay or baleage to dairy heifers on growth, feed efficiency, and rumen parameters during the transition and growth phases. In the transition phase, 60 Holstein heifers (312.9 ± 2.6 lb BW) were randomly assigned to 1 of 12 pens and fed a 40:60 forage-to-concentrate (F:C) diet (DM basis) containing either dry hay **(H)** or baleage **(B)** as the forage source for 4 wk. In the growth phase, 36 of the heifers (408.6 ± 2.9 lb BW) remained on the same forage treatments (12 pens; n = 31/pen) and were fed a 60:40 F:C diet for an additional 8 wk. Heifers were weighed weekly during the transition phase and biweekly during the growth phase. Heights, heart girth circumference **(HGC)**, and body condition scores **(BCS)** were measured, and blood was collected for analysis monthly. Rumen fluid was collected via esophageal tube and measured for pH, rumen ammonia, and in vitro cellulose digestion. Data were analyzed by phase as repeated measures using PROC MIXED of SAS with pen as the experimental unit. In the transition phase, ADG was greater for H than for B (2.23 and 1.96 lb/day, respectively; $P < 0.05$), yet final BW were similar ($P > 0.10$). Feed efficiency of H was 0.071 compared to 0.037 lb BW gain/lb DMI for B at the end of the transition phase ($P < 0.05$), and DMI was similar between treatments over the study ($P > 0.10$). Rumen pH was greater for B than for H at wk 2 (6.85 and 6.58, respectively; $P < 0.05$), and rumen ammonia levels were greater for H at wk 2 ($P < 0.01$) with concentrations of 15.5 and 11.7 mg/dl for H and B, respectively. Cellulose digestion was similar between treatments ($P > 0.10$). Plasma urea nitrogen was greater for H at both wk 2 and 4 ($P < 0.05$). In the growth phase, H heifers were 14.8 lb heavier ($P < 0.01$) and gained 1.39 lb/day compared to 1.23 lb/day for B heifers ($P < 0.05$). Overall, H consumed 0.66 lb/day more DM than B ($P < 0.01$), resulting in a tendency for a 5.4% improvement in feed efficiency for H compared to B ($P < 0.10$). Cellulose digestion tended to be 9.4% greater for H compared to B ($P < 0.10$). Hip and wither heights, HGC, and BCS were similar between treatments for both phases ($P > 0.10$). In summary, feeding baleage decreased BW gain but did not alter skeletal growth in prepubertal dairy heifers.

Limited Suitability of Dietary Coconut Oil to Reduce Enteric Methane Emission from Dairy Cattle

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Dietary medium-chain fatty acids contained in coconut oil **(CO)** reduce synthesis of enteric methane in ruminants. Feeding 0.0, 1.3, 2.7, and 3.3% CO in dietary dry matter to lactating Holstein dairy cows (> 77 lb/day 4% fat-corrected milk yield **[FCMY]**) led to daily enteric methane emissions of 462, 446, 291, and 250 g/cow, respectively. However, CO reduced intake of dietary energy. Apparent NDF digestion and FCMY were reduced in a quadratic fashion. The results of the 4 dietary treatments (scenarios) were modeled to simulate enteric methane emissions: 1) for the national-level (U.S.) dairy herd to maintain national FCMY; and, 2) for a representative dairy farm with a constant number of all dairy animals (n = 356) across scenarios. We assumed constant enteric methane emissions per unit of gross energy intake from all pregnant, non-lactating cows and replacement heifers in all scenarios. Total cows plus replacements needed to maintain national FCMY in each of the 4 scenarios were 13.9, 13.4, 17.5, and 18.1 million, respectively. Enteric methane reduction per unit of FCMY was 8 and 12% for the 2.7 and 3.3%-CO scenarios, respectively, compared with the 0.0%-CO scenario. This did not account for additional environmental costs for extra feed production associated with increased feed needs of 5.5 and 6.3%, respectively. Enteric methane emissions and feed needs were reduced by 6.0 and 8.1%, respectively, in the 1.3%-CO scenario compared with the 0.0%-CO scenario. Additionally, CO reduced utilization of ration NDF (human-indigestible fiber) for FCMY in both models. In the farm-level model, acreage needed to supply all forages and corn grain for rations was reduced from 319 ac/yr to 306, 277, and 269 ac/yr for the respective scenarios. However, annual FCMY also declined: 148, 160, 136, and 135 cwt/ac, respectively. Thus, revenue from reductions in enteric methane emission must compensate for the loss of income from reduced milk sales to remain financially sustainable in the latter 2 scenarios. Improvements with the 1.3%-CO scenario are due primarily to increased FCMY per cow and enhanced feed conversion efficiency. Consequently, there was only minor, if any improvement, in sustainability of national- and farm-level dairy production predicted by these models when CO was fed to partially inhibit enteric methane emissions.

Effects of Variable Dietary Fat Concentrations on Lactating Dairy Cows

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High fat variation, coupled with high dietary inclusion rates of dried distillers grains with solubles (**DDGS**), can lead to a highly variable fat content in the total diet. Our hypothesis was that variable dietary fat would have a negative effect on DMI and milk yield and composition. Twenty-four Holstein cows in two blocks of 12 (average DIM=140) were used in a 3×2 Latin square with two 16-day periods. A 12-day washout period (all cows fed the control diet) separated the periods. Cows received one of three treatments, 1) control, 2) moderate fat variability (**MFV**), or 3) high fat variability (**HFV**). The control diet was formulated to have a constant dietary fat concentration of 5.9% of DM by including 23.7% distillers grains (without solubles) (**DG**) and adding 1.1% corn oil to reach a dietary fat concentration of 5.9%. This would be equivalent to a 25% inclusion of average DDGS. The MFV and HFV treatments were formulated to have an average dietary fat concentration of 5.9% of DM over the 16-day period but with fat concentrations that varied over time. The MFV treatment had a phase of low fat (5.4%) for 4 days (25.4% DG with 0.6% corn oil), followed by a 4-day high fat (6.4%) phase (22.1% DG with 1.7% corn oil). The HFV treatment consisted of a 4-day low fat (4.8%) phase (27.0% DG with 0% corn oil), followed by a 4-day high fat (7%) phase (20.4% DG with 2.2% corn oil). All phases were repeated for a total of 4 phases or 2 total cycles per period. Daily DMI and milk yield were measured, and milk samples were collected at the start of each period, and on the 2nd and 4th day of each phase and analyzed for fat and fatty acid concentrations. The statistical model included block, cows within block, period, and treatment with repeated measures (i.e., day within period) using the MIXED procedure of SAS. Cows on the HFV had lower DMI than cows on the other treatments (45.8 vs. 48.3 lb/day), but no treatment by day interaction was observed and DMI did not follow a cyclical pattern (high when higher fat diets were fed and low when lower fat diets were fed). Treatment affected milk yield (80.0, 81.8, and 77.4 lb/day for control, MFV, and HFV), and a treatment by day interaction was observed; however, milk yields did not follow a cyclical pattern. Milk fat was not affected by treatment (mean of 2.4%), but a day by treatment interaction was observed. Milk fat was depressed across treatments and could have been a result of the high concentration of polyunsaturated fatty acids **(PUFA)** in all the diets. Trans-10 isomer of C18:1 (**t10FA**) in the milk was not affected by treatment (mean of 4.2% of total milk fatty acids), but a day by treatment interaction was observed. A negative correlation has been shown between t10FA and milk fat; however, in this experiment, milk fat did not follow a cyclical pattern; whereas, t10FA had a very clear cyclical pattern. Treatment affected *trans*-10, *cis*-12 conjugated linoleic acid **(CLA)** in the milk (0.036, 0.042, and 0.047% of milk fatty acids for control, MFV and HFV) ,and there was a day by treatment interaction. This CLA has been shown to inhibit *de novo* fatty acid synthesis in the mammary gland; however, in this experiment, milk fat was not correlated with this CLA. A very high day to day variation of dietary fat concentration (far greater than would be observed on commercial farms) over a short term had little effect on DMI and milk production, and only a transient effect on milk fatty acids.

Effects of Alternative Housing and Feeding Systems on the Performance of Dairy Heifer Calves

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Most calves in the dairy industry are housed individually prior to weaning. However, this type of housing limits the calves' ability to display social behavior, which may impede development of normal social responses. Individual housing is often preferred to reduce incidence of disease, increase weight gain, and minimize undesirable behaviors, such as cross-sucking. Previous studies have indicated that if calves are fed with a bottle instead of a bucket, these undesirable behaviors may be reduced. The present study investigated the effects of housing and milk feeding method on the production performance of dairy calves. Eighty-two female Holstein calves were allocated to treatments at 6 ± 3 days of age and monitored for approximately 9 wk. Treatments were as follows: individual housing fed with a bucket, individual housing fed with a bottle, paired housing fed with a bucket, or paired housing fed with a bottle. Two experimental sites were utilized. Calves were housed in hutches (non-tethered, wire pen) at Site 1 (n=34) and in wire-panel pens in a feed commodity shed at Site 2 (n=48). Calves allocated to the individual treatment were housed in a single hutch at Site 1, whereas calves assigned to the paired treatment were housed by joining two adjacent hutches with doubling of the pen size. Pasteurized whole milk was fed via bucket or bottle twice a day (6 L/day). Calves had ad libitum access to calf-starter (same at both sites) and water. Gradual weaning commenced at wk 6 by reducing the calves' milk allowance by 2 L/wk. Calves were weaned at the beginning of wk 8. Grain consumption and body weight were monitored on a weekly basis and wither height measured at the beginning and end of the experiment. Data were analyzed using the MIXED model procedure of SAS. Total DM intake (grain and milk solids) was higher for calves housed in pairs compared to those housed individually (3.89 ± 0.06 versus 3.72 ± 0.06 lb/day; $P = 0.04$). Although not significant, average daily gain **(ADG)** was higher for Site 1 compared to Site 2 (1.56 ± 0.07 versus 1.42 ± 0.05 lb/day; $P = 0.12$). Bottle feeding also tended to increase ADG compared to bucket feeding (1.55 ± 0.06 versus 1.42 ± 0.07 lb/day; $P = 0.13$). Change in wither height was greater at Site 1 (13.5 ± 0.5 versus 9.5 ± 0.4 cm; $P < 0.0001$) and for calves housed individually (12.2 ± 0.4 versus 10.8 ± 0.5 cm; $P = 0.03$). In conclusion, housing young calves in pairs may enhance feed intake due to social facilitation.

Essential Oil and Rumensin Affect Ruminal Fermentation in Continuous Culture

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The combination of Rumensin® (Elanco, Greenfield, IN) and essential oil could be beneficial for ruminal fermentation by suppressing protozoa and their associated methanogens, while maintaining normal rumen function. The objective of this study was to determine the effects of feeding Rumensin and Cinnagar® (essential oil from cinnamon and garlic) in diets on ruminal fermentation characteristics. Four continuous culture fermenters were modified to retain protozoa (slower stirring and a special filter apparatus) and maintained at a liquid dilution rate of 7%/h and solids dilution rate of 5%/h in 4 periods of 10 days each (7 days of adaptation) in a 4 X 4 Latin square design. Four dietary treatments (fed in 1 meal per day) were arranged in a 2 x 2 factorial: (1) control diet, 40 g of a 50:50 concentrate:forage (ground alfalfa hay) diet (40% NDF, 17% CP) containing no additive; (2) Rumensin at 11g/909 kg of DM; (3) Cinnagar at 0.0043% (DM basis); and (4) a combination of Rumensin and Cinnagar. There were no effects ($P \geq 0.22$) of treatment on NDF and OM digestibilities, concentrations of NH_3-N and total VFA, and percentage of protozoal generic distribution. Rumensin (main effect, no interaction) decreased ($P < 0.05$) molar percentages of acetate (62.6 vs 64.4 mol/100 mol) and valerate (1.78 vs 1.86 mol/100 mol); decreased acetate:propionate ratio (2.69 vs 3.04); and increased ($P < 0.05$) propionate (23.3 vs 21.3 mol/100 mol) and isovalerate (1.94 vs 1.67 mol/100 mol). Rumensin increased ($P < 0.05$) the protozoa generation time (27.6 vs 21.6 hours). Cinnagar tended ($P = 0.11$) to increase isovalerate (1.77 vs 1.67 mol/100 mol) and decrease the protozoa counts (14.9 vs. 18.5 x 10^3/ml). Rumensin and Cinnagar tended ($P = 0.06$) to interact for methane production (29.3, 22.4, 21.8, and 36.7 mmol/days, respectively). Under the conditions of our study, we did not detect an additive response for Rumensin® and Cinnagar® to decrease protozoal counts or methane production.