

## Ruminant Nutrition: Dairy—Calves and Heifers

**439 An evaluation of the calf and heifer models within the 2001 Dairy NRC publication.** M. Van Amburgh\*, *Cornell University, Ithaca, NY.*

The objective of this abstract is to evaluate the applicability and biology of both the calf and heifer chapters and software found in the Nutrient Requirements of Dairy Cattle, 7th Ed. publication. The chapter on calves has been well received. New body composition data was generated that allow for refinements to the calf model (Bartlett, 2001; Blome et al, 2003; Diaz et al., 2001; Tikofsky et al., 2001). The equation used to estimate the net energy (NE) requirements for calves (Toullec, 1989) was based on heavier calves fed lower protein diets than dairy replacement calves; thus the predicted NE required is higher than the current data sets. Also, the efficiency of use of metabolizable energy to NE was set at 0.69 based on the Toullec data, but re-evaluation using the current data suggests a value 0.60 consistent with less mature calves accreting less fat and greater tissue protein. The committee used the Blaxter-Mitchell equation that uses the biological value (BV) of protein to estimate the absorbed protein required. The committee adopted the value of 0.80 for the BV, however, if a static value is applied, a more reasonable value appears to be 0.72. Also, immunological and growth data indicated modifications should be made to the requirements for vitamins A and E. The heifer model has received more stringent reviews from both academics and industry professionals. New terminology and substantial changes in the biology were implemented which slowed adoption primarily because of inadequate information about how to apply biology. Evaluations of the NE predictions indicate the equations are reasonable when compared to slaughter data (Moallem et al., 2004), however, application to whole animal growth demonstrate that heifers grow more rapidly than predicted which leads to over-conditioning. Using 0.086 Mcal of NEM per kg metabolic BW might be too high despite some references to the contrary and that 0.077 might be applicable to Holsteins. The protein system applied to heifers appears to underestimate requirements and over-estimate supply in heifers lighter than puberty and this might be due to using data derived from lactating dairy cattle.

**Key Words:** Calf, Heifer, Evaluation

**440 Feeding neonatal calves starters with different protein concentrations in conventional and high protein milk replacer feeding regimes.** M. Hill\*, J. Aldrich, and R. Schlotterbeck, *Akey, Lewisburg, OH.*

Our objective was to re-evaluate the effect of CP in a starter offered to calves less than 63 d and fed either a 20% CP, 20% fat milk replacer (MR; trial 1) at 454 g daily or a 26% CP, 17% fat MR at 681 g daily (trial 2). All values in abstract are on an as-fed basis. In each trial, 48 calves less than one week of age were offered the MR at a fixed rate. Water and starter was fed free choice from 0-56 d. In trial 1, calves were weaned at either 28 or 42 d (factor 1) and fed starters containing 15, 18, or 21% CP (factor 2). This was analyzed as a CRD with 2X3 factorial arrangement. Initial BW and serum protein averaged 41 kg and 5.7 mg/dl and did not differ. The effects of increasing starter CP increased gain, gain to feed (efficiency), and hip width change linearly ( $P < .05$ ) from 0-42 d, but quadratically ( $P < .05$ ) from 0-56 d (calves fed starters with 15% CP had the lowest values). Starter protein did not affect starter intake, body condition score change, and health related measurements. Weaning age did not affect gain from 0-56 d, however, calves weaned at 28 d tended ( $P < .1$ ) to grow slower from 28-42 d, but faster from 42-56 d. Calves weaned at 28 d consumed more ( $P < .05$ ) starter from 0-56 d than calves weaned at 42 d. Calves weaned at 42 d were more efficient from 0-42 d. There were no differences in body condition score change, hip width change, and health related measurements between weaning at 28 and 42 d. In trial 2, the MR was fed from 0-42 d. Starters containing 18 or 21% CP were fed in a RBD design. Initial BW and serum protein averaged 40 kg and 5.3 mg/dl and did not differ. There were no differences for gain, starter intake, efficiency, fecal scores, hip width change, and body condition score. Starters containing 18% CP are adequate, consistent with previous trials from our research nursery, other published trials, and the dairy NRC (2001, 1989).

**Key Words:** Protein, Starter, Calf

**441 Effects of continuous versus periodic milk availability on the behavior and performance of dairy calves.** F. Wolf<sup>1</sup>, M. Hotzel<sup>1</sup>, M. von Keyserlingk<sup>2</sup>, and D. Weary<sup>2</sup>, <sup>1</sup>*Univ. de Santa Catarina, Brazil,* <sup>2</sup>*Animal Welfare Program, University of British Columbia, Vancouver, Canada.*

Previous work has shown that dairy calves fed milk ad libitum engage in feeding activity throughout a 24-h period. However, providing calves with continuous access to milk can present practical problems with milk quality, particularly during warm weather. One way to maintain milk quality would be to limit the time that milk is available, but to date no research has addressed the effects of limiting the time that milk is available. The objectives of this study were to quantify the effects of continuous access (24 h/d) versus access to milk during only part of the day on milk feeding behavior and performance. Thirty-four Holstein calves were randomly assigned to 1 of 3 treatments at  $5 \pm 3$  d of age and monitored for 21 d. In each condition, calves had ad libitum access to milk delivered through a teat, and free access to water from a bowl and to calf starter. Treatments were: 1) access to milk for 24 h/d (24 h); 2) access to milk for 2 feedings/d each of 2 h, with water available through the teat the remainder of the day (4hW) and, 3) access as described in 4hW, but with no water available through the teat (4hD). Milk intake did not differ between the 4hW and 4hD treatments, averaging  $9.9 \pm 0.3$  kg/d, but was higher for calves given 24 h access to milk ( $11.1 \pm 0.4$  kg/d;  $P = 0.03$ ). However, there was no difference in ADG between calves fed on the different treatment, with gains averaging  $1.1 \pm 0.04$  kg/d. In total calves in the 24-h treatment spent more time on the teat than those calves on the 4-h treatments ( $26.4 \pm 1.8$  vs.  $18.8 \pm 1.2$  min/d, respectively;  $P < 0.002$ ), but during the 4 h/d when milk was available to all calves, calves in the 4-h treatments spent more time on the teat ( $11.3 \pm 1.1$  vs.  $16.4 \pm 0.8$  min/d, respectively;  $P = 0.001$ ). These results show that calves fed ad libitum milk for only 4 h/d compensate by changing their milk feeding behavior and achieve similar weight gains to animals fed milk continuously.

**Key Words:** Milk Feeding, Calves, Feeding Behavior

**442 Effects of weaning age and milk feeding frequency on calf growth, health and rumen parameters.** S. I. Kehoe\* and A. J. Heinrichs, *The Pennsylvania State University, University Park.*

Recommended strategies for feeding calves attempt to improve performance while decreasing labor requirements. Two trials were conducted to determine effects of age at weaning and feeding frequency on calf growth, health and rumen development. For each trial, 60 Holstein calves were weaned at 3, 4, 5 or 6 wk of age. During trial 1, milk replacer was fed at 10% BW (12.5% DM; 22% CP, 15% fat) in two feedings until 1 wk prior to weaning when intake was reduced to 5%. During trial 2, calves were fed 10% BW in two feedings until 14 d at which milk replacer was fed at 10% BW once daily until 1 wk prior to weaning when it was reduced to 5% BW. Blood glucose, blood urea nitrogen (BUN), rumen VFA and ammonia, and growth parameters, including BW, heart girth, hip height and wither height were obtained weekly. Trial 1: Growth and structural parameters were not different between treatments by wk up to 8 wk of age ( $P > 0.05$ ). BW at 8 wk were  $73 \pm 3.1$  kg. BUN concentrations were lower for treatments 3 and 4 at weaning than treatments 5 and 6. Glucose concentrations were higher for treatments 3 and 4 at weaning than treatments 5 and 6. Major rumen VFA concentrations as well as health parameters were not different between treatments. Weaning does not affect growth and measured rumen parameters indicating equal performance for calves weaned early. Trial 2: Growth and structural parameters were not different between treatments by wk up to 8 wk of age. BW at 8 wk were  $76 \pm 3.1$  kg. BUN concentrations were lower for treatments 3 and 4 at weaning than treatments 5 and 6. Glucose concentrations were higher for treatments 3 and 4 at weaning than treatments 5 and 6. Major rumen VFA and health parameters measured were not different between treatments. Feeding once daily does not have adverse effects on weaning age indicating producers can utilize this option for feeding calves. Similar growth and performance between treatments in both trials through 8 wk of age indicates that producers can save labor costs by weaning early and feeding once daily while maintaining calf performance.

**Key Words:** Weaning, Once Daily Feeding

**443 Effect of Apex botanicals on calves fed pasteurized milk or milk replacer (MR) during the nursery phase and subsequent grower phase until four months of age.** M.k Hill\*, J. Aldrich, and R. Schlotterbeck, *Akey, Lewisburg, OH.*

The objective of this trial was to evaluate 0 or 227 mg Apex (BFI Innovations) added to the liquid diet of 48 individually penned calves during d 0-42. Subsequently, 0 or .026% Apex added to calf grower diet during d 57-112 was fed to the same 48 calves in 8 pens of 6 calves each. From 0-42 d, either 3.8 L (530 g DM, 131 g CP, 152 g fat) of pasteurized whole milk (72° C for 15 seconds) or 681 g (660 g DM, 176 g CP, 118 g fat) of a 26% milk protein, 17% fat MR powder was fed daily in two equal feedings. Starter (18% CP) and fresh water were offered ad lib from 0-56 d. Data were analyzed as a CRD with factors of liquid diet and Apex. Data from the 57-112 d grower phase were analyzed as a CRD for carry-over effects from feeding Apex in the liquid diet during d 0-42 (factor 1) and for the effect of feeding Apex during the grower phase of d 57-112 (factor 2). In the nursery phase, calves fed MR grew 25% faster (529 vs. 421 g/d), had a greater gain to feed efficiency, greater change in body condition score, and greater change in hip width from 0-42 d than calves fed milk ( $P < .05$ ). In the nursery phase, calves fed Apex gained 13% faster (505 vs. 445 g/d;  $P < .05$ ) during d 0-42, tended to gain 16% faster ( $P < .1$ ) during d 43-56 after the calves were weaned from the liquid diet, and gained 15% faster (628 vs. 546 g/d;  $P < .05$ ) from 0-56 d. Calves fed milk with Apex grew 21% faster from 0-42 d than calves fed milk without Apex. Calves fed MR with Apex grew 7% faster from 0-42 d than calves fed milk without Apex. During the 57-112 d grower phase, there was a carry-over effect from the nursery phase for Apex to increase (1.09 vs. 1.02 kg/d;  $P < .05$ ) gain by 6% and a trend ( $P < .1$ ) to decrease gain to feed efficiency by 5%. Calves fed Apex during the grower phase gained 7% faster (1.10 vs. 1.02 kg/d;  $P < .05$ ). Apex improved calf gain during both the nursery/liquid and weaned/grower phases from 0-112 d.

**Key Words:** Botanicals, Milk, Calf

**444 Influence of starter protein content on growth of dairy calves in an enhanced early nutrition program.** J. A. Stamey\*, N. A. Janovick Guretzky, and J. K. Drackley, *University of Illinois, Urbana.*

Our objectives were to determine the effect of starter crude protein (CP) content on growth of Holstein calves from birth to 10 wk of age in an enhanced early nutrition program, and to compare the enhanced program to a conventional milk replacer program. A total of 89 calves (64 female, 25 male) were assigned to three treatments in a randomized block design: 1) conventional milk replacer (20% CP, 20% fat) plus conventional starter (19.6% CP, DM basis), 2) enhanced milk replacer (28.5% CP, 15% fat) plus conventional starter, and 3) enhanced milk replacer plus high-CP starter (25.5% CP, DM basis). Calves began treatments ( $n = 29, 31, \text{ and } 29$  for treatments 1 to 3) at 3 d of age. Conventional milk replacer was reconstituted to 12.5% solids and fed at 10% of birth weight daily in two feedings from wk 1 to 5 and at 5% of birth weight once daily during wk 6. Enhanced milk replacer was reconstituted to 15% solids and fed at 1.5% of BW as DM during wk 1 and 2% of BW as DM during wk 2 to 5, divided into two daily feedings. During wk 6, enhanced milk replacer was fed at 1% of BW as DM once daily. Calves were weaned at d 42. Starter was available ad libitum starting on d 3. Over the 10-wk study, average daily gain of BW (0.65, 0.74, and 0.81 kg/d) was greater for calves fed enhanced milk replacer ( $P < 0.001$ ), and tended to be greater ( $P = 0.07$ ) for calves fed high CP starter. Rates of change in wither height, body length, and heart girth were greater for calves fed enhanced milk replacer ( $P < 0.05$ ) but did not differ between starter CP concentrations. The BW for enhanced treatments was unaffected by starter CP content at weaning (62.8, 73.1, and 73.4 kg;  $P = 0.88$ ) and 10 wk (91.3, 96.0, and 99.4 kg;  $P = 0.27$ ). Additionally, starter CP content did not affect height, length, or heart girth at weaning or 10 wk (all  $P \geq 0.25$ ) within enhanced milk replacer treatments. Starter with 25.5% CP (DM basis) provided only modest benefits in growth for dairy calves in an enhanced early nutrition program compared with a conventional starter (19.6% CP).

**Key Words:** Calves, Growth, Milk Replacer

**445 Influence of starter protein content on growth and body composition of dairy calves in an enhanced early nutrition program.** J. A. Stamey\*, F. K. McKeith, N. A. Janovick Guretzky, and J. K. Drackley, *University of Illinois, Urbana.*

Our objectives were to determine the effect of starter crude protein (CP) content on body composition of male Holstein calves from birth to 10 wk of age in an enhanced early nutrition program and to compare the enhanced program to a conventional milk replacer program. Calves ( $n = 46$ ) were purchased on the day of birth and assigned to a randomized block design. Eight calves were harvested at baseline and remaining calves were divided among three dietary treatments: 1) conventional milk replacer (20% CP, 20% fat; 10% of birth weight) plus conventional starter (21.5% CP, DM basis); 2) enhanced milk replacer (28.5% CP, 15% fat; 1.5% of BW as DM for wk 1, 2% of BW as DM wk 2-5, 1% of BW as DM wk 6) plus conventional starter; and 3) enhanced milk replacer plus high-CP starter (26% CP, DM basis). Calves began treatments on d 2 or 3 of age. Calves were weaned at d 42. Starter was available ad libitum starting on d 3. Calves from each treatment were harvested at 5 and 10 wk of age and divided into three fractions: carcass; viscera; and head, hide, feet, and tail. Fractions were analyzed for energy, N, lipid, and ash. Average weekly starter intake did not differ ( $P = 0.81$ ) between enhanced treatments. Plasma urea N concentration differed among all treatments (7.6, 9.8, and 12.1 mg/dl;  $P < 0.0001$ ). Plasma glucose was lower ( $P < 0.05$ ) for conventionally fed calves. Gain of BW (0.46, 0.72, and 0.74 kg/d;  $P < 0.001$ ) was greater for enhanced treatments but was unaffected by starter CP ( $P = 0.78$ ). Body length and heart girth were greater for enhanced treatments ( $P < 0.01$ ) but did not differ between starter CP content. Carcass weights at 5 wk (31.6, 41.3, 39.3 kg) were greater for enhanced treatments but did not differ between starter CP content. At 10 wk, carcass weights were heavier for enhanced calves and heavier for high CP starter (41.6, 50.6, 52.0;  $P = 0.05$ ). Carcass lipid percentage did not differ among treatments ( $P \geq 0.48$ ). A high CP starter had minimal impact on dairy calves in an enhanced early nutrition program.

**Key Words:** Calves, Growth, Body Composition

**446 Using mixture enzyme as feed additive in growing diets of young Holstein calves.** A. Naserian<sup>1</sup>, B. Saremi<sup>2\*</sup>, and M. Sari<sup>1</sup>, <sup>1</sup>*Ferdowsi University, Mashhad, Khorasan Razavi, Iran*, <sup>2</sup>*Animal Science Department, Education Centre of Khorasan Jihad-Agriculture, Mashhad, Khorasan Razavi, Iran.*

In order to investigate effects of enzyme addition to young calves diet and its effects on their performance, eighteen female Holstein calves (birth weight 39.5±5.1 kg) were placed in different treatments after weaning: 1) control 2) 0.5% enzyme 3) 1% enzyme. The commercial enzyme (NATUZYME, Bioproton, Au) was a mixture of cellulase, xylanase, B-glucanase, A-amylase, protease, pectinase and phytase and was used for non-ruminants up to now. Calves were fed 10% birth weight milk up to weaning at 60 days old and they had free access to water and feed. Diets were formulated according to NRC 2001 to meet calves requirement. Calves were weighed and body measurements (wither height, hip height, body length, pin width, hip width, stomach size, heart girth, metacarpus size and metatarsus size) were taken periodically (60, 80, 100 and 120 days old). Intake of calves was measured daily. Feed to gain ratio was determined. Rumen (pH) and blood samples (glucose, BUN) were taken at sampling dates. Data were analyzed using completely randomized design with SAS 6.12. Means were compared using Duncan test. Results showed that daily dry matter intake was reduced using enzyme as feed additive ( $P < 0.01$ ) but daily gain of calves was increased non significantly so that feed to gain ratio was improved with enzyme increase up to 1% ( $P > 0.05$ ). Body measurements were improved with enzyme addition to calves diet that in some cases there were significant differences between treatments ( $P < 0.01$ ) like wither height at 120 days old and body length increased during 60 day trial. Rumen pH, blood glucose and BUN were not affected by enzyme addition. Data showed that increasing level of enzyme up to 1% could improve performance of calves without side effects on rumen characteristics and blood metabolites during weaning to 4 months old.

**Key Words:** Young Calves, Mixture Enzyme, Performance

**447 Nutrient digestibility and excretion of dairy heifers fed diets with increasing concentrations of corn distillers grains.** K. F. Kalscheur\*, P. Exbrayat, and A. D. Garcia, *South Dakota State University, Brookings.*

The objective of this experiment was to determine nutrient utilization of dairy heifers fed increasing concentrations of dried corn distillers grains with solubles (CDG). Six Holstein heifers ( $387 \pm 17$  kg body weight) were used in a replicated  $3 \times 3$  Latin square design with 2-wk periods. Dried distillers grains were included in diets at three concentrations: 0, 12.5, and 25% of the diet DM. Bromegrass hay and corn silage remained constant across diets (54.2 and 15% of the diet DM), and corn and soybean meal was replaced by CDG as its inclusion rate increased. Diets (DM basis) were formulated to be similar in CP (13.2%), NDF (49.2%) and ADF (26.9 %). Dietary fat increased from 1.5 to 3.9% and phosphorus (P) from 0.30 to 0.45% (DM basis) as CDG increased in the diet from 0 to 25%. Urine and feces were collected for 4 days at the end of each period to calculate nutrient digestibility and excretion. Dry matter intake was restricted according to NRC recommendations and did not differ as CDG increased in the diets (8.3, 8.1, and 8.3 kg/d). Average daily gain increased linearly as CDG was increased in the diets (0.88, 1.10, and 1.64 kg/d;  $P < 0.07$ ). Total tract digestibility of DM, NDF, and ADF was not affected by diet. Total tract digestibility of CP decreased (68.9, 67.8, and 63.8%;  $P < 0.003$ ) as CDG in the diet increased. Although nitrogen (N) intake was not different (178, 172, and 173 g/d), fecal N increased (55, 55, and 63 g/d;  $P < 0.001$ ) and urinary N decreased (102, 96, and 86 g/d;  $P < 0.001$ ) as CDG increased in the diets. As P intake increased (25, 27, and 38 g/d;  $P < 0.001$ ) with increased dietary CDG, fecal P output also increased (20, 22, and 28 g/d;  $P < 0.001$ ). Increasing CDG in dairy heifer diets resulted in decreased CP digestibility and increased fecal N excretion. Urinary N excretion however was reduced, which resulted in similar total N excretion across diets. Phosphorus excretion increased at higher CDG concentrations as a result of feeding in excess of the requirement of growing dairy heifers.

**Key Words:** Corn Distillers Grains, Nutrient Digestibility and Excretion, Dairy Heifers

**448 The effects of altering dry matter intake on rumen digestion and turnover in dairy heifers.** G. I. Zanton\* and A. J. Heinrichs, *Pennsylvania State University, University Park.*

The objective of this experiment was to elucidate the effects of differing intakes of dry matter on ruminal parameters of growing, postpubertal dairy heifers. A grass-based, total mixed ration (49.1% NDF, 13.0% CP) was fed to eight rumen cannulated Holstein heifers (340 +/- 5 kg) in a replicated  $4 \times 4$  Latin square design at levels of intake formulated to equally span the region between approximately maintenance and ad libitum consumption for 35 days per period. Treatments consisted of one ration fed at 1.25, 1.50, 1.75, and 2.00 kg per 100 kg body weight twice daily with energy being the first-limiting dietary component. Rumen fluid was collected every two hours for 24 hours on one day each period. In situ incubations of the TMR were conducted each period for each heifer and analyzed for DM, CP, and NDF. Rumen contents were evacuated midway between the morning and evening feeding on one day per period. Data were analyzed as a Latin square design and linear and quadratic contrasts were tested. Rumen pH was linearly reduced and total VFA concentration linearly increased as DMI increased ( $P < 0.05$ ), but molar proportions of acetate, propionate, and butyrate and rumen concentrations of ammonia were unaffected by treatment and were not differentially affected by time after feeding ( $P > 0.05$ ). Rate and extent of in situ DM degradability was not significantly different between the different levels of intake ( $P > 0.05$ ). The weight of wet rumen contents, dry rumen contents, and rumen content DM percentage were linearly increased by increasing DMI ( $P < 0.05$ ), while NDF percentage was not altered by treatment. Apparent turnover of rumen DM was linearly decreased by increasing levels of DMI from 26.9 to 23.0 hours ( $P < 0.05$ ), likely due to an increase in rate of passage owing to similar rates of digestion. Likewise, NDF turnover was linearly decreased by increasing DMI from 37.1 to 33.2 hours ( $P < 0.05$ ) indicating an increased potential for ruminal digestion of dietary NDF. These results highlight the importance that DMI has on the ruminal availability of DM and NDF for dairy heifers.

**Key Words:** Dairy Heifers, Rumen Turnover, Rumen Digestion