149 Effects of intensive whole-milk feeding in calves on subsequent growth of dairy heifers. Camila Flávia de Assis Lage[1], Mariana Magalhães Campos[2], Fernanda Samarini Machado[2], Paulo Campos Martins[1], Luigi Francis Lima Cavalcanti*[3], Marcelo Neves Ribas[3], Luiz Gustavo Ribeiro Pereira[2], Thierry Ribeiro Tomich[2], Rafael Alves de Azevedo[1], and Sandra Gesteira Coelho[1], *[1]Federal University of Minas Gerais, Belo Horizonte, Minas Gerais, Brazil, [2]EMBRAPA Dairy Cattle, Coronel Pacheco, Minas Gerais, Brazil, [3]CNPq, RHAE – SEVA Engenharia, Projeto Intergado, Contagem, Minas Gerais, Brazil.*

The effects of intensive whole milk feeding in calves on subsequent growth of Holstein-Gyr females was evaluated. Up to 56 d old, calves received 6 L/d of 4 different liquid diets consisting of whole milk with increasing addition of milk replacer (Sprayfo Violet SSP) to adjust the concentration of total solids (TS) to 13.5 (n = 15), 16.1 (n = 15), 18.2 (n = 13), 20.4% (n = 15). After weaning, animals were randomly housed in 4 paddocks, each one equipped with electronic feed and water bins (Intergado, Brazil) in Embrapa Dairy Cattle facilities, Brazil. Diet (70:30, corn silage:concentrate, 195 g CP/kg, DM basis) was fed ad libitum, twice a day, until 210 d old. The withers height (WH), hip height (HH), rump width (RW) and chest circumference (CC) measures were carried out fortnightly using a flexible tape measure and a teletape (Ketchum, Canada). WH and CC were analyzed as a completely randomized design with repeated measures using nonlinear mixed models approach. A regression model ($Y(age) = A+(B – A) \exp[–\exp(–c \times age)]$, where Y = response at a specific age, A = asymptote as age $\rightarrow\infty$, $B = Y_{(0)}$, and c = logarithm of the rate constant) was fit to the data, where age and function parameters were allocated as fixed effects while animal was considered as random. It was evaluated the necessity of adding random terms to model error dependence and heteroscedasticity by monitoring Schwarz criterion, estimates stability and correlation. HH and RW, due to their linear growth pattern, were analyzed by linear mixed models, allowing polynomial models of first and second degree orders to model variable change over time ($\alpha = 0.05$). All variables were steadily influenced by age, but only WH and CC were influenced by TS. For both responses, the c parameter was linearly increased by TS, revealing that a more intensive feeding strategy increases the growth rate of these 2 traits. TS influenced all CC parameters, where increasing total solid level caused a linear decrease of A, while increased B. TS effects over parameters A and B should be interpreted with parsimony, because animals in the present study had not achieved their mature weight.

Key Words: milk replacer, intensive farming, heifer

150 Effect of bacteria level in colostrum on dairy heifer serum IgG concentration. Christine Cummins and Emer Kennedy*, *Teagasc, Ireland.*

Storage of colostrum >4°C increases total bacterial count (TBC) which may compromise passive transfer of immunity. This experiment investigated the effect of colostrum stored at varying temperatures, to induce a difference in bacteria levels, on the rate of passive transfer of immunoglobulin G (IgG) in dairy heifer calves. Colostrum was collected immediately postpartum from Holstein-Friesian (HF) cows, tested for IgG concentration, and assigned to 1 of 5 treatments: (1) pasteurized, (2) fed when freshly collected, (3) stored at 4°C for ≥48 h (fridge), (4) stored at 13°C ≥48 h, and (5) stored at 22°C ≥48 h. Colostrum fed to each calf was tested for TBC, using serial dilution and IgG concentration using radial immunodiffusion (RID; Triple J Farms, WA). Seventy-five HF and HF × Jersey (JEX) heifer calves were removed from their dam and assigned to a treatment immediately postpartum at Teagasc Moorepark Research Farm, from 3 Feb to 25 Mar 2014. A randomized block design accounting for breed, birth date and birth weight (BW) was used. Calves were fed 8.5% of their BW in colostrum via stomach tube within 2 h. Calf blood samples were collected at 0 and 24 h of age and analyzed for IgG concentration using RID. Data were checked for normality and the MIXED procedure in SAS was used to examine the effect of treatment on serum IgG concentration. Pasteurised colostrum had a TBC <9,000 cfu/mL, fresh colostrum had 68,000 cfu/mL; both below the recommended level of 100,000 cfu/mL. Colostrum stored at 4°C had a TBC > 2 million cfu/mL, currently not recommended for feeding. Colostrum stored at 13°C and 22°C had significantly higher ($P < 0.01$) TBCs (>92 and >1000 million cfu/mL, respectively). Colostrum stored at 22°C had the lowest IgG concentration (62 g/L). The overall average colostrum IgG concentration across all treatments was 97 g/L. Zero-hour serum contained no IgG. Serum IgG of calves at 24 h from the pasteurised, fresh and 4°C treatments were similar, but were significantly higher ($P < 0.05$) than colostrum from the 13°C and 22°C treatments. Colostrum with high levels of bacteria reduced IgG absorption in dairy calves. Colostrum should be stored ≤ 4°C to minimize bacterial growth and improve subsequent passive transfer of IgG.

Key Words: calf, IgG, colostrum

151 Performance of calf reared on waste milk or nonmedicated milk replacer contained sodium butyrate and *Bacillus amyloliquefaciens*. O. V. Vazquez-Mendoza[1], A. E. Kholif[2], M. M. Y. Elghandour[3], A. Z. M. Salem*[3], V. L. Garcia-Flor[4], and T. A. Morsy[2], *[1]Norel México S.A. de C.V., Parque Industrial El Marqués, Querétaro, México, [2]Dairy Science Department, National Research Centre, Giza, Egypt, [3]Facultad de Medicina Veterinaria y Zootecnia, Universidad Autónoma del Estado de México, Toluca, Estado de México, Mexico, [4]Centro de Ciencias Agropecuarias, Universidad Autónoma de Aguascalientes, Aguascalientes, México.*

More interest is paid for the accelerated growth programs for dairy calves through enhancing early nutrition programs based on greater rates of liquid feeding for better mammary gland development and milk production. Appropriate supply of nutrients for calves through liquid feed including milk or milk replacer is essential for better performance and welfare. In a completely randomized design, the nutritional and economic efficiencies, and growth performance of 18 Holstein female dairy calves (41 ± 3.7 kg BW, 1 d old) fed either pasteurized waste milk (PWM) or calf milk replacer (CMR) were tested. Calves were fed colostrum (IgG; 70–100 mg/mL) within the first 2 h of life at the rate of 10% of their BW, and then offered 2 L every 12 h for 3 d, without access to solid feed. Calves were fed individually on PWM (n = 9) or CMR containing *Bacillus amyloliquefaciens* and sodium butyrate (n = 9) twice daily at 0900 and 1600 h for 60 d. From the fourth day, calves were offered pelleted starter feed (180 g CP and 338.2 g of NDF/kg DM) in the morning at 0900 h. Water was provided ad libitum. Health condition, body measurements, fecal bacteriological analysis and economic analysis were measured. No differences were observed for liquids and total starter intakes; however, calves fed on PWM consumed more ($P < 0.05$) starter DM during the period from d-16 to d-45 with greater metabolizable energy intake. Greater ($P < 0.05$) BW changes

for PWM-calves than CMR-calves during the period from d-30 to d-60; with higher ($P < 0.05$) average daily gains during the period from d-16 to d-60. Health conditions did not differ between calves with greater faces score and lower cough score for CMR-calves. Calves fed CMR had greater fecal number from *Klebsiella oxytoca* and *Proteus vulgaris* with the same count of *E. coli*. Greater economic evaluation ($P < 0.0001$) for CMR-calves than PWM-calves were obtained. It could be concluded that the CMR can be used efficiently rather than PWM without reducing feed efficiency and with more profits in feeding dairy calves during the pre-weaning period.

Key Words: calf, health condition, milk replacer

152 Effects of colostrum feeding programs on passive immunity, health, and performance of Holstein dairy calves. Weina Shi and Zhijun Cao*, *China Agricultural University, Beijing, China.*

The objective of this study was to investigate effects of 4 colostrum feeding programs on passive transfer of immunity, health, and growth performance of Holstein dairy calves before 70 d age. Experiment 1, 76 newborn Holstein calves (24 bulls and 52 heifers) were blocked by colostrum quality and sex and assigned randomly to 4 treatments. Calves were housed in individual hutches and were moved to the heifer pens at the age of 9 week. Colostrum feeding programs were as follows: calves in T_{322} were fed 3 L at 0 h (birth), 2 L at 6 h, and 2 L at 12 h; calves in T_{402} were fed 4 L at 0 h and 2 L at 12 h; calves in T_{400} were fed 4 L only at birth; calves in T_{220} were fed 2 L at 0 h and 2 L at 6 h. Blood sample collected at 24 h after birth showed that serum total protein (TP, g/dL) and IgG (mg/mL) levels were significantly higher for calves in T_{322} (TP = 6.11 g/dL, IgG = 22.49 mg/mL, $P < 0.01$) and T_{402} (TP = 5.89 g/dL, IgG = 19.99 mg/mL, $P < 0.05$) compared with calves in T_{400} (TP = 5.56 g/dL, IgG = 16.05 mg/mL) and T220 (TP = 5.58 g/dL, IgG = 16.31 mg/mL). At 48 h after birth, serum TP and IgG levels were significantly higher for calves in T_{322} (TP = 6.37 g/dL, IgG = 25.61 mg/mL, $P < 0.01$) and T_{402} (TP = 6.12 g/dL, IgG = 22.61 mg/mL, $P < 0.01$) compared with calves in T_{400} (TP = 5.58 g/dL, IgG = 16.30 mg/mL) and T_{220} (TP = 5.66 g/dL, IgG = 17.24 mg/mL). Experiment 2, 40 heifers in experiment 1 were involved. Results showed that the incidence and frequency of diarrhea and the fecal index tended to be greater ($P > 0.05$) in T_{400} and T_{220} than in the other 2 treatments. At the first week post-weaning, calves from T_{322} (1536.54 g/d, DM, $P < 0.01$) and T_{400} (1321.23 g/d, DM, $P < 0.01$) had significantly higher starter intake than that of calves from T_{220} (1162.01 g/d, DM). These results suggest that colostrum feeding program 322 (3 L at 0 h, 2 L at 6 h, and 2 L at 12 h) and 402 (4 L at 0 h and 2 L at 12 h) can improve passive Immunity, health, and growth performance of Holstein dairy calves compared with the other 2 feeding programs. Further research is needed to evaluate the influence of colostrum feeding programs on later growth, reproduction and lactation performance of dairy cattle.

Key Words: colostrum, passive immunity, growth performance

153 Influences of SmartCare in milk replacer and XPC in calf starter on the performance and health of preweaning Holstein calves challenged with *Salmonella enterica* serotype Typhimurium. Tyler L. Harris*[1], Yu Liang[1], Matt D. Sellers[1], Jeff A. Carroll[2], Ilkyu Yoon[3], Mark F. Scott[3], and Michael A. Ballou[1], *[1]Department of Animal and Food Sciences, Texas Tech University, Lubbock, TX, [2]USDA-ARS, Lubbock, TX, [3]Diamond V, Cedar Rapids, IA.*

This study investigated how supplementing milk replacer with SmartCare (SC) and calf starter with original XPC (XPC) would affect performance and health following an oral challenge with *Salmonella enterica* serotype Typhimurium. The study was performed in 2 35 d periods with 30 Holstein bull calves per period. In each period, calves were blocked by location in the barn and randomly assigned to treatments that included: CON: base milk replacer and calf starter with no added products, SC: milk replacer with 1 g SC/calf/d and base calf starter, and SC+XPC: milk replacer with 1 g SC/calf/d and calf starter with 0.5% XPC. Calves were fed 350 g of milk replacer at 0700 and 1700. Calf starter and water were offered ad libitum and recorded daily. Calves were challenged with 10^8 cfu of sulfamethazine-resistant *Salmonella enterica* orally on d 14 of the study. Fecal *Salmonella* shedding was determined on d 14 to 21, and d 24, 28, and 35 using selective media. Blood samples were collected on d 0, 7, 14, 16, 18, 21, 24, 28, and 35 and analyzed for hematology. Contrasts were analyzed to determine SC and XPC effects. All data were reported as CON, SC, and SC+XPC, respectively. The LSMeans with various superscripts differ ($P \leq 0.05$). Calf starter intake (0.178^a, 0.218^{ab}, $0.254^b \pm 0.022$ kg) was improved in both SC and SC+XPC (SC contrast $P = 0.029$; XPC contrast $P = 0.035$). Average daily gain (0.48^a, 0.48^a, $0.58^b \pm 0.028$ kg) was greater among SC+XPC calves vs. the other treatments (XPC contrast, $P = 0.001$). Post challenge, the SC+XPC calves had a lower neutrophil to lymphocyte ratio (0.81^a, 0.83^a, $0.69^b \pm 0.051$) vs. CON and SC calves (XPC contrast, $P = 0.005$). The SC+XPC calves also had lower hematocrits (35.1^a, 35.3^a, $33.4^b \pm 0.54\%$) and hemoglobin concentrations (10.8^a, 10.6^a, $10.1^b \pm 0.16$ mg/dL) after the challenge. Fecal *Salmonella* shedding tended to be reduced by both SC and SC+XPC (3.21, 2.84, 2.42 ± 0.279 d shedding; SC and XPC contrasts $P \leq 0.071$). Calves fed both SC in milk replacer and XPC in calf starter had improved performance and enteric health.

Key Words: calf, health, yeast culture

154 Effect of feed type and presentation on feeding behavior, intake, and growth of dairy calves fed a high level of milk. Morgan A. Overvest*[1], Renee Bergeron[2], Derek B. Haley[3], and Trevor J. DeVries[1], *[1]Department of Animal and Poultry Science, University of Guelph, Guelph, ON, Canada, [2]Department of Animal and Poultry Science, University of Guelph, Campus d'Alfred, Alfred, ON, Canada, [3]Department of Population Medicine, Ontario Veterinary College, University of Guelph, Guelph, ON, Canada.*

The objective of this study was to assess the effect of different feed types and method of feed presentation in the first 12 wk of life on the feeding behavior, intake and growth of calves fed a high milk level. Forty-eight neonatal Holstein calves (~24 h old) were individually housed and randomly assigned to 1 of 4 treatments: silage-based total mixed ration (TMR), concentrate (CON), and chopped hay and concentrate presented in 2 manners: mixed (MIX) or separate (SEP). All calves were offered 12L/d of acidified milk replacer until d 38 at which time step-down weaning by 1 L/d began. At d 50 calves no longer received milk and all calves on SEP and CON treatments were offered the MIX diet until the end of the trial while TMR and MIX calves did not change feeds. Feed intakes were recorded daily and calves were weighed 2x/wk. For the last 2 d during wk 3, 5, 7, 9, and 11 video recordings were analyzed for time spent feeding. Data were summarized by week and analyzed in a repeated measures general linear mixed model. In the preweaning stage (d 1–37) ADG was similar for all calves (1.1 kg/d; SE = 0.05; $P = 0.16$). TMR calves had lower ADG than calves on the other 3 treatments during both the weaning (d 38–49; 0.2 vs. 0.7 kg/d; SE = 0.06; $P < 0.01$) and post-weaning (d 50–84; 0.5 vs 1.2 kg/d; SE = 0.09; $P <$

0.01) stages. This result is related to the lower DMI of calves fed TMR in comparison to MIX, SEP and CON calves in the weaning (0.2 vs. 0.5 kg/d; SE = 0.07; $P < 0.01$) and post-weaning (1.8 vs. 2.8 kg/d; SE = 0.17; $P < 0.01$) stages. It should be noted that, given DM content of the feeds (TMR = 52%, all other diets = 89%), the as-fed intake of the calves was actually similar ($P \geq 0.40$) across treatments in all 3 stages. Interestingly, TMR calves spent more time feeding during the postweaning stage than MIX, SEP and CON calves (308 vs 194 min/d; SE = 16.0; $P < 0.001$). It appears that during weaning and post-weaning, calves fed TMR were attempting to maximize their nutrient intake, but were unable to match that of those in other treatments due to the high moisture content of their feed, and thus were unable to perform at a similar level.

Key Words: dairy calf, weaning, feeding behavior

155 Extensive, noninvasive measurements of body temperature and posture in neonatal Holstein dairy calves bedded with deep straw in response to changes in ambient temperature and amount of milk replacer fed. T. Mark Hill*, H. Gale Bateman, II, F. Xavier Suarez-Mena, James D. Quigley, and Rick L. Schlotterbeck, *Nurture Research Center, Provimi North America, Cargill Premix and Nutrition, Brookville, OH.*

Posture of calves can be influenced by nutrition and ambient temperature. Calf tail vein temperature (a proxy for body temperature) and standing time were extensively measured in 14 male calves (46 ± 1.5 kg initial BW) between 4 and 18 d of age. Thermocrons (Maxum Integrated Products Inc.) were taped to the tail vein to capture temperatures hourly. Accelerometers (Onset Computer Corp.) were attached to a plastic ankle bracelet and taped to the medial side of the right, rear leg to record posture every minute. Calves were fed free-choice dry feed and water and a 27% CP, 17% fat (DM) milk replacer fed at 2 rates (0.66, LOW, and 1.0 HIGH, kg DM daily) in 2 equal meals fed at 0600 and 1600 h. Calves were bedded with deep straw and maintained in an unheated, naturally ventilated, curtain-sided nursery with a well-drained rock floor. Ambient temperature averaged 2.5°C (daily averages ranged from −2.4 to 8.1°C). Data were analyzed as repeated measures in a randomized ANOVA to test MR rate and with linear regression analysis to test ambient temperature and time. Mean calf temperature was 38.4 ± 0.11°C and it changed diurnally with a 0.5°C daily range being highest at night ($P < 0.05$). Calf temperature was 0.1°C greater for calves fed a HIGH vs. LOW rate and it increased 0.02°C per 1°C ambient temperature ($P < 0.05$). Standing time averaged 299 ± 17 min/d and it increased 7.1 min daily with age and decreased 2.6 min daily per 1°C ambient temperature ($P < 0.05$). Standing bouts (a standing plus lying event) averaged 16.2 ± 0.5 daily and decreased 0.3 bouts daily per 1°C ambient temperature ($P < 0.05$). Bouts were 2.8 more daily for caves fed at the high vs. low rate and these extra bouts occurred during the AM and PM meals ($P < 0.05$). Standing time and bouts changed over the 24-h day and were greatest during the AM and PM meals, intermediate during the day between meals, and were the least overnight ($P < 0.05$). Feeding more milk replacer slightly increased body temperature and increased standing bouts during meals. A greater body temperature and less standing time overnight suggests that calves bedded with deep straw during cold temperatures conserved body heat by lying.

Key Words: calves, posture, temperature

156 Commercial dairy farm evaluation of highly digestible corn grain for calf starters when calves are fed pasteurized waste milk. David P. Casper*[1] and Mark Kirk[2], [1]*South Dakota State University, Brookings, SD,* [2]*Masters Choice, Anna, IL.*

New corn hybrids have been developed by Masters Choice (MC) that vary in energy density and starch digestibility. These MC hybrids have lower starch densities due to an altered starch structure, which allows for greater ruminal and intestinal starch digestion. Our previous work (Casper et al. 2014) had demonstrated improved nutrient digestibilities, feed efficiency, and reduction in cost of gain when feeding a calf starter (CS) based on MC corn when calves were fed an accelerated milk replacer (28:18 CP:fat). Forty-five (1 to 3 d old) Holstein heifer calves raised on a large commercial Eastern South Dakota Dairy Operation were randomly assigned to 1 of 3 CS to evaluate growth performance of Holstein heifer calves through 7 wk of age from mid-June 15 through mid-August, 2013. Treatments were: 1) Control (C) CS: containing 40% (DM basis) conventional ground shelled corn 24% CP; 2) MC CS: containing (40% DM basis) MC corn and 24% CP; and 3) Standard commercially available CS (S) being fed at the dairy operation containing 16% conventional corn and 16.5% CP. All CS were fed as a pellet. Colostrum was fed the first 3 d of life and then pasteurized waste milk was fed twice daily at a rate of 3.78l L/d for 2–13 d, 5.68 L/d for 14–35 d, and once daily at 2.85 L/d for 35–42 d of age. Feedings were reduce to 1x/d at 35 d to facilitate weaning at 42 d and the study ended at 49 d. Calves were housed in individual poly hutches with ad libitum CS and water. Data were analyzed as a completely random design using the PROC MIXED procedure of SAS Version 9.4. Initial body weights were similar ($P > 0.08$) for calves fed all CS (38.8, 37.5, and 34.9 kg for C, MC, and S, respectively). Body weight gains (18.0, 16.8 and 13.6 kg) and average daily gains (0.34, 0.32, and 0.28 kg/d) were greater ($P < 0.03$) for calves fed C and MC compared with calves fed S CS. Calves fed MC CS gained greater ($P < 0.03$) more body length (4.6, 12.9, and 6.4 cm) than calves fed C or S. Feeding a higher CP CS improved growth rates, but MC CS further increased body length when fed pasteurized waste milk during the summer heat stress.

Key Words: waste milk, corn hybrid, calf starter

157 Vitamin D status of dairy calves fed pasteurized whole milk. Jessica L. Powell*[1], Kathryn E. Merriman[1], Mary E. Drewnoski[2], and Corwin D. Nelson[1], [1]*University of Florida, Gainesville, FL,* [2]*University of Nebraska, Lincoln, NE.*

Calves need vitamin D to support bone growth and immunity. Feeding dairy calves pasteurized whole milk is a common practice, but the vitamin D status of milk-fed calves has not been widely appreciated. The objectives of this study were to determine serum 25-hydroxyvitamin D (25D) concentrations of dairy calves fed pasteurized whole milk and the effects of subcutaneous vitamin D injections on serum 25D concentrations of milk-fed dairy calves. Two experiments were conducted on 2 separate farms and serum 25D concentrations were measured using a 25D ELISA. In the first experiment, 23 Holstein calves received a vitamin AD&E (1200 IU α-tocopherol, 400,000 IU retinyl-palmitate, and 40,000 IU vitamin D_3; n = 11) or saline injection (n = 12) at birth, and were fed pasteurized whole milk and housed indoors. Serum 25D concentrations of the control calves were 8.1 ± 1.0, 11.2 ± 2.6, 13.0 ± 3.2, and 13.3 ± 1.6 ng/mL (mean ± SE) at 0 d, 7 d, 22 d, and 37 d of age, respectively. In contrast, serum 25D concentrations of the vitamin AD&E treated calves were the same as control calves at birth (10.0 ± 1.0 ng/mL), greater at 7 d and 22 d (25.4 ± 2.8 and 24.9 ± 3.4 ng/mL,

respectively; $P < 0.05$), and not different from controls at 37 d (14.3 ± 1.6 ng/mL; treatment x time interaction, $P < 0.05$). In the second experiment, 13 Holstein bull calves received either 80,000 IU of vitamin D_3 via subcutaneous injection at birth and once weekly for 3 weeks (n = 5) or no injection (control, n = 8), and were fed pasteurized whole milk and housed under shaded structures. Serum 25D concentrations of the non-treated calves were 13.4 ± 3.3, 5.1 ± 3.4, 8.0 ± 4.1, and 8.7 ± 4.9 ng/mL (mean ± SE) at 0 d, 7 d, 14 d, and 21 d of age, respectively. In the vitamin D-treated calves, serum 25D was the same as control calves at birth, but was increased to 25.6 ± 4.4, 38.1 ± 5.2, and 41.2 ± 6.2 ng/mL (mean ± SE) at 7 d, 14 d and 21 d of age, respectively (treatment x time interaction, $P < 0.01$). In conclusion, milk-fed dairy calves, particularly if housed indoors or under shade, are at risk for vitamin D deficiency (serum 25D < 10 ng/mL) if they do not receive supplemental vitamin D, and continuous vitamin D supplementation is needed to maintain vitamin D status of calves.

Key Words: dairy calf, nutrition, vitamin D

158 Gradual weaning affects pre- and postweaning feed intake, growth, and gastrointestinal development in Holstein calves fed an elevated plane of nutrition during the pre-weaning stage. Michael A. Steele*[1,2], Leonel Leal[3], Michelle Carson[1], John H. Doelman[1], and John A. Metcalf[1], *[1]Nutreco Canada AgResearch, Guelph, Ontario, Canada, [2]University of Alberta, Edmonton, Alberta, Canada, [3]Nutreco Research and Development, Boxmeer, the Netherlands.*

The short and long-term benefits of feeding elevated quantities of milk have been recently been established and these feeding strategies have been implemented in many production systems worldwide. The objective of this study was to characterize the effect of abrupt and gradual weaning when calves are fed an elevated plane of nutrition (1.35 kg/d milk replacer) in a twice-daily feeding scheme. At total of 55 calves were randomly assigned to treatments of abrupt (0 d step-down) or gradual (12 d step-down) weaning at 48 d of life. Calves were housed and sampled in individual pens for the duration of the experiment. Milk, starter, straw and water intake was measured on a daily basis. Bodyweight was measured every 6 d until d 35 and every 3 d thereafter, while blood, rumen fluid and fecal matter was collected on d 35, 48 and 54 of the experiment. Although the growth rates of the step-down calves were lower from d 35 to weaning (0.48 ± 0.08 vs. 1.00 ± 0.10 kg/d; $P < 0.01$), the post-weaning average daily gain was greater compared with the abruptly weaned group (0.86 ± 0.12 vs. 0.15 ± 0.10 kg/d; $P < 0.01$). Total rumen volatile fatty acid concentration was greater in the step-down group compared with the abrupt group on the day of weaning on d 48 (76.84 ± 1.28 vs. 46.72 ± 0.78 mmol; $P < 0.01$). Fecal starch percentage was lower postweaning compared with the abruptly weaned calves on d 54 (2.97 ± 1.28 vs. 6.67 ± 1.22%; $P < 0.05$), whereas serum amyloid A concentration was not affected by weaning strategy. These results showcase the benefits of a step-down feeding scheme from an overall energy balance standpoint in twice daily feeding schemes, presumably due to the increased opportunities for the gut to adapt before weaning.

Key Words: calf, weaning, development

159 Effects of pre- and postweaning nutrition on growth, efficiency, and rumen fermentation of Holstein calves. Tana S. Dennis*[1], Michael W. Grott[1], Brad W. Shelton[1], and Tamilee D. Nennich[1,2], *[1]Purdue University, West Lafayette, IN, [2]Famo Feeds, Freeport, MN.*

The objective of this study was to evaluate the interaction of preweaning and postweaning nutrition on calf performance, blood metabolites, and rumen fermentation. Holstein calves (43.5 ± 5.1 kg BW at birth; 39 heifers and 18 bulls) were assigned at 1 d of age to 1 of 4 treatments in a randomized complete block design with a 2 × 2 factorial arrangement of treatments. Preweaning milk replacer (MR) treatments were a 22% CP, 20% fat (as-fed basis) MR (C) or 28% CP, 20% fat MR (H), with weaning based on starter intake. Postweaning treatments were low NFC (27% NFC on DM basis; LC) or high NFC (42% NFC; HC) grower diets fed individually for ad libitum intake from 12 to 28 wk of age. Weights, skeletal measurements, and blood were taken every 2 wk during the preweaning period. Postweaning, BW were taken every 2 wk and skeletal measurements, blood, and rumen fluid were collected monthly. Pre- and postweaning periods were analyzed separately and overall from birth to 28 wk. Calves fed H were 15 d older, 18.0 kg heavier, and consumed 58% more DM through weaning compared with C ($P < 0.01$); however, feed efficiency (FE) was similar between H and C from birth to weaning ($P = 0.24$). From weaning to 11 wk, DMI was 53% greater for C ($P < 0.01$); however, ADG from weaning to 11 wk was similar, resulting in greater ADG from birth to 11 wk for H ($P < 0.01$). Hip height, hip width, and heart girth increased 2.7, 3.6, and 3.7%, respectively, for H over C at 8 wk ($P < 0.01$). Postweaning, ADG was improved for HC ($P = 0.01$), resulting in an 8.7 kg advantage in BW at 28 wk ($P = 0.04$). Total DMI was similar between postweaning treatments, and FE was significantly improved for HC from 12 to 28 wk ($P < 0.01$). Rumen fermentation and blood profiles were altered in favor of decreased acetate ($P = 0.09$), increased butyrate ($P = 0.01$), and reduced rumen NH_3 and plasma urea N ($P < 0.01$) for HC. Overall, calves fed H^+HC were 12.4 kg heavier at 28 wk compared with calves fed H^+LC, but similar in BW to calves fed C+HC. These results suggest calves fed a high plane of nutrition preweaning should continue to receive high planes of nutrition postweaning to maintain growth advantages.

Key Words: dairy calf, weaning, growth

160 Commercial dairy farm evaluation of milk replacers with different protein sources and concentrations. K. A. Froehlich*[1], U. Salga Vegas[1], C. Soderholm[2], and D. P. Casper[1], *[1]South Dakota State University, Brookings, SD, [2]Milk Specialties Global, Eden Prairie, MN.*

High protein (accelerated) milk replacers (MR) have increased skeletal frame growth and average daily gain (ADG) in dairy calves. However, high protein MR often cost more money than dairy producers are willing to spend for the improved performance. Our objectives were to determine the growth performance of calves fed a 24/20 (protein/fat) MR made from alternative protein sources that equal the cost of a 20/20 all milk protein MR. Eighty-eight Holstein calves raised on a South Dakota (SD) commercial dairy operation were blocked by birth date and randomly assigned to 1 of 3 treatments consisting of a control 20:20 all milk protein MR (C20), 24:18 all milk protein MR (C24), and a 24:18 alternative protein MR (A24) where the CP sources were based on 11% milk, 5% wheat, and 8% plasma. Colostrum was fed the first 3 d of life and then MR was fed at a rate of 0.68 kg/calf/d at twice daily for 35 d via bottle. Feedings were reduce to once daily at 36 d to facilitate weaning at 42 d. All MR had neomycin and oxytetracycline added at 1,330 g/ton each and supplemented with SAF Mannan. Calves were housed in individual poly-dome hutches bedded with straw with ad libitum access to a 20% CP calf starter (CS) and water. Calves fed all 3 MR were similar ($P > 0.10$) in ADG (0.59, 0.63, 0.63 kg/d for C20, C24, and A24, respectively). Gains in body weight, hip width, wither

height, and body length during the 56 d study were similar ($P > 0.10$) among calves fed all MR. Calves fed C24 MR had greater ($P < 0.05$) gains in hip height than calves fed C MR (6.2, 10.6 and 8.5 cm) with calves fed A24 being intermediate. Calves fed A24 MR tended ($P < 0.08$) to have greater gains in heart girth (15.8, 16.8 and 18.0 cm) than calves fed C20 with calves fed C24 being intermediate. Feeding a MR having more protein can support greater frame growth. The use of wheat and plasma protein to replace portions of all milk protein in MR can result in better frame growth when calves are raised on a commercial dairy. Thus, feeding a 24/18 MR can be cost neutral to the feeding of a 20/20 MR, but potentially support improved frame growth.

Key Words: calf, wheat protein, plasma protein