

Growth and Development I

T272 Effects of resistant starch in milk replacer on fecal volatile fatty acids and pH and performance in neonatal Holstein calves. C. C. Williams*, B. F. Jenny, B. L. Fisher, A. H. Dolejsiova, E. L. Chartier, and E. Eckelkamp, *LSU AgCenter, Baton Rouge, LA.*

Resistant starch (RS) may help in preventing intestinal disturbances in calves. Thirty female Holstein calves were assigned to 1 of 3 treatments at 2 d of age to study effects of adding commercial resistant wheat starch to milk replacer (MR) on growth and health. Treatments were 0, 4, or 8g RS mixed into reconstituted MR. Calves were housed in hutches and fed MR until 56 d of age. MR was fed once daily according to body weight (BW), 10% of BW containing 15% solids. Initial amount of MR fed was based on birth weight and was increased at 7, 14, 21, and 28 d according to BW change and then held constant until weaning at 56 d. An 18% crude protein calf starter was offered ad libitum beginning on d 29 throughout the duration of the trial. Water was offered ad libitum beginning on d 3. Calves remained in hutches until d 70 to determine post weaning performance. BW was determined at birth and weekly throughout the trial. Withers height (WH), hip height (HH) and hip width (HW) were measured on d 7, 14, 28, 42, 56, and 70 of age. Feed intake and fecal scores were recorded daily. Fecal samples were collected weekly beginning at d 7 for analysis of pH and volatile fatty acids (VFA). Blood was collected on d 14, 28, 42, 56, and 70 for analysis of hematocrit (HCT), plasma urea nitrogen (PUN) and total protein (TP). Effects of treatment, week, and their interactions were analyzed using the MIXED procedure of SAS. HCT, PUN and TP did not differ ($P > 0.05$) and were within normal ranges suggesting no major metabolic problems. There was no effect ($P > 0.05$) of treatment on BW, HH, HW, WH, or fecal scores. There was a week effect ($P < 0.01$) for grain intake, with all calves increasing intake throughout the duration of the study. There was a week effect ($P < 0.01$) for fecal scores, with calves having lower fecal scores at the end of the study compared with the beginning. There was no effect ($P > 0.05$) of treatment on fecal pH or concentrations of VFA. Overall, incorporation of RS in the milk replacer of neonatal dairy calves did not show any significant effects on growth or gut health of Holstein dairy calves.

Key Words: dairy calf, resistant starch, milk replacer

T273 Effects of a simplified feeding program on growth and rumen development of dairy calves C. Julien^{*1,2}, B. Gestes^{1,2}, C. Lacroux³, C. Bayourthe^{1,2}, and F. Enjalbert^{1,2}, ¹INRA, UMR1289 TANDEM, Tissus Animaux Nutrition Digestion Ecosystème et Métabolisme, Castanet-Tolosan, France, ²Université de Toulouse, INPT ENSAT, INP-ENVT, UMR1289 TANDEM, Castanet-Tolosan, France, ³UMR INRA ENVT 1225, Interactions Hôte Agent Pathogène, Ecole Nationale Vétérinaire de Toulouse, 23 Chemin des Capelles, Toulouse, France.

The experiment aimed at testing the effect of a simplified feeding program on growth and rumen development of dairy calves ("Technique Once a Day," Bonilait-Protéines, France). It was carried out on 16 male Holstein calves from birth (d1) to weaning (d63) moved to individual pens at birth. Two feeding programs were tested. Each one was based on a milk replacer (MR), with the same proportions of dairy proteins (from skim milk powder and/or whey protein concentrate) and the same chemical composition: 20% CP and 18% fat, on DM basis. Calves were divided into 2 groups at 4 d of age: (1) OAD (n = 8): calves received MR once a day (200 g/L of MR), (2) TAD (n = 8): calves received MR (125 g/L) twice a day; volume distributed per calf and per meal varied with age but did not differ between groups leading to a total of 34.1 and 40.9 kg/calf of MR over 63d for OAD

and TAD, respectively. The week before weaning, all calves received MR once a day. All calves received water, wheat straw and a starter concentrate (16.6% CP) ad libitum. Four calves per group were harvested at weaning. Reticulo-rumen, omasum and abomasum were emptied, cleaned and weighted separately and carcass weight (CW) was recorded. Rumen epithelium was sampled at a fixed location (ventral sac) and fixed in a neutral 10% formaldehyde solution. Rumen papillae (RP) were counted and averaged on 3 1cm² areas by image analysis (Visilogue 6.5 Noesis, France). The mucosa was observed for histopathologic investigation. Body weight of calves averaged 45.9 ± 5.7 kg and 96.3 ± 11.4 kg at birth and weaning, respectively, without significant difference between treatments. Total stomachs weight (5.2% of CW, on average) and relative weights of reticulo-rumen (62.9%), omasum (16.8%) and abomasum (20.3%) did not differ with treatment. The RP count were higher ($P = 0.03$) for OAD calves (84.8 RP/cm²) than TAD (64.7 RP/cm²) and no pathologic abnormality was detected. Simplifying dairy farmer practices by giving MR once a day to dairy calves is possible without compromising calves' growth and reticulo-rumen development but effects on welfare remain not evaluated.

Key Words: calf, rumen, papillae

T274 Comparison of planes of nutrition on growth performance and rumen papillae development of dairy calves. J. A. Davidson^{*1}, B. L. Miller¹, H. C. Puch¹, T. J. Earleywine², K. M. O'Diam³, and K. M. Daniels³, ¹Purina Animal Nutrition Center, Gray Summit, MO, ²Land O'Lakes Animal Milk Products, Shoreview, MN, ³Ohio Agricultural Research and Development Center, The Ohio State University, Wooster.

The objective was to determine if the plane of nutrition combinations of specific protein:fat milk replacer and starter affect the growth performance of dairy calves from 0 to 84 d of age and subsequently altered the rumen papillae surface area. Holstein bull calves (n = 16) were assigned to 1 of 2 nutritional programs: conventional (C) or full potential (FP). Conventional program consisted of feeding 454 g DM/d of a 20:20 milk replacer and 18% CP starter. Full potential program consisted of 818 g DM/d of a 28:20 milk replacer followed by increased feeding rate to 1136 g DM/d at d 10 of age and 22% CP starter. Milk replacer was offered twice daily from 0 to 44 d of age, and calves were weaned (d 45) with 50% reduction in milk replacer DM for 6 d. Starter was offered ad libitum from 0 to 84 d of age. Body weight (BW, kg) and hip height (HH, cm) measurements were completed every 2 weeks. Calves were euthanized at 28, 56, or 84 d of age (2 per program at each age) to examine ruminal papillae characteristics. Four regions of the rumen were analyzed for muscle and sub-mucosal thickness, and length and area of the papillae. On d 42, 49, 56, and 84, calves fed FP had greater BW gains of 11.0, 8.9, 7.5, and 4.7 kg (SE = 2.77, $P = 0.05$) over gains of C fed calves. Average gains of frame were also greater for FP of (SE = 1.08, $P = 0.02$) relative to C fed calves. Sub-mucosal thickness and papillae area were different ($P < 0.05$) for age and region of rumen. Greatest increases of sub-mucosal thickness were observed in the caudal ventral region from d 28 to 84 of age, regardless of nutritional program. At d 28 of age, papillae area and length could not be measured digitally. At d 56, the ruminal papillae area were 4.8 and 6.5 mm² for FP and C fed calves, whereas at d 84 ruminal papillae area were 11.6 and 9.5 mm², regardless of region (SE = 1.55, ns). Growth performance was greater for calves fed a FP program, whereas rumen papillae area and sub-mucosal thickness increased similarly with age, regardless of the nutritional program.

Key Words: calf, papillae, growth

T275 Whole oats effects on digestive system development in neonatal dairy calves. F. X. Suarez-Mena^{*1}, A. J. Heinrichs¹, T. M. Hill², and C. M. Jones¹, ¹The Pennsylvania State University, University Park, ²Nurture Research Center, Provim North America, Lewisburg, OH.

The objective of this experiment was to study effects of whole oats in starter grain on digestive system development of pre-weaned calves. Male Holstein calves (n = 8, 42.5 ± 2.0 kg BW at birth) were fitted with a rumen cannula in wk 2 of life. Calves were housed in individual pens in a heated facility; bedding was covered with landscape fabric to avoid any consumption of bedding. Water was offered free choice, and milk replacer was fed to 12% of birth BW. A fixed amount of starter (containing 25% oats either ground and in the pellet or whole) was offered daily based on average intakes of calves on similar milk replacer diets; orts were fed through the cannula. Calves were randomly assigned to all pelleted starter (P, n = 4) or pellets plus whole oats (O, n = 4). Rumen contents were sampled at -8, -4, 0, 2, 4, 8, and 12 h after grain feeding for pH determination at wk 3, 4, and 5 of age. At 35 ± 1 d of age calves were euthanized, and organs were harvested, emptied, rinsed, and weighed to gauge digestive organ development. Total starter intake (3 wk; 4,596 P vs. 4,449 O ± 111 g) was not different (*P* > 0.05). Digestive organ mass was analyzed as a percentage of BW at harvest. Reticulorumen (0.81 P vs. 0.81 O ± 0.05%) and liver (2.21 P vs. 2.25 O ± 0.08%) were not different (*P* > 0.05). Omasum (0.16 P vs. 0.19 O ± 0.01%) was greater (*P* < 0.05), and abomasum (0.40 P vs. 0.46 ± 0.02%) had a tendency to be greater (*P* < 0.10) for O. Rumen papillae length (0.67 P vs. 0.59 ± 0.05 mm), width (0.48 P, 0.45 O ± 0.02 mm), and rumen wall thickness (0.96 O vs. 0.90 O ± 0.09 mm) were not different (*P* > 0.05). Average rumen digesta pH at 3 wk of age (6.32 P vs. 6.22 O ± 0.16) was higher (*P* < 0.01) than at 4 (5.93 P vs. 5.85 O ± 0.16) and 5 (5.86 P vs. 5.74 O ± 0.16) wk; pH was not different (*P* > 0.05) between treatments. Whole oats had no effect on reticulorumen weight or rumen papillae size but increased omasum and abomasum weight. Lack of treatment effect on papillae may be related to calves eating grain for only 3 wk. Rumen digesta pH decreased with age likely as a consequence of greater intake of starch and digestible nutrients.

Key Words: calf, rumen development, oats

T276 Puberty attainment is affected by growth performance before 4 mo of age in dairy heifers. V. Lollivier^{1,2}, F. Dessauge¹, M. Boutinaud^{*1}, and Y. Le Cozler^{1,2}, ¹INRA UMR1348PEGASE, Saint Gilles, France, ²Agrocampus Ouest, UMR1348 Pegase, Rennes, France.

In seasonal calving systems where heifers first calved at a young age, age at 1st insemination may be delayed for those born at the end of the calving period. A possible alternative is to increase growth intensity during the 1st year of rearing, and then, to reduce age at 1st calving (21 mo of age or less). Puberty should then occur at an early age for optimal fertility. A long-term experiment aiming at studying the effect of controlled growth intensity throughout feeding procedure is being conducted since 2009 including 60 to 70 Holstein heifers / year. In 2012, the effect of rearing intensity on puberty attainment was closely studied on 65 heifers born between August 26 and December 27, 2011. Animals born before December 1 were either fed a standard (SD) or an intensive (ID) diet from 0 to 6 mo of age, to reach 190 to 200 kg or 220 to 230 kg at 6 mo of age, respectively. Animals born after received ID until artificial insemination (AI). From 5.5 mo of age, blood samples were obtained from jugular vein every 10 d to determine plasma progesterone concentration. The plasma progesterone analyses were performed with AIA 360 robot. The intra- and inter-assay variabilities were 12.3 and 7.5%, respectively. Blood samples were collected until synchronization or AI. Single Anova analyses were performed through R Software. Puberty was detected on 56 animals, at an

average age of 10.2 (±2.0) mo and 296 (±37) kg body weight (BW). Age varied between 6.2 and 14.4 mo, whereas BW was comprised between 224 and 369 kg. Because of huge ADG variations within feeding regimen and limited number of observations, no effect of SD or ID was noted on puberty onset. Puberty occurred earlier when average daily gain (ADG) before weaning (77 to 80 d of age on average) increased (9.7 vs. 10.8 mo when ADG varied from less than 700 g/d to 700 g/d or more respectively; *P* < 0.05). To a lesser extent, ADG from weaning to 4 mo of age also affected puberty onset. In agreement with previous published studies, this study indicates that enhanced growth program during lactating phase and/or early stages of rearing may affect puberty attainment.

Key Words: heifer, puberty, onset

T277 The effect of various dilutions, milk replacer dry matter, and volume amounts on calf growth and performance. T. J. Earleywine, B. L. Miller, W. S. Bowen Yoho^{*}, and T. E. Johnson, Land O' Lakes, Inc., Webster City, IA.

Feeding an established volume of milk replacer (MR) solution without regard for dry matter (DM) by lowering the percentage solids is being done by producers. The objective of this study was to examine the effects of delivering a more dilute solution at the same volume on calf growth and performance. One hundred thirty-three (133) 3–10 d old Holstein calves with an average initial BW of 47.6 kg (SD = 2.21 kg) were shipped from Wisconsin to the Land O' Lakes Research Facility. Calves were randomly assigned according to BW and blood gamma globulin to one of 4 27% all milk protein/10% fat MR diets varying in dilution, MR DM, and volume amount. Days 8–49, treatments were as follows: High Solids, High DM, Low volume (HS/HDM/LV; 17.6% solids, 1.13 kg DM, 6.62 L solution/d); Medium Solids, High DM, Medium volume (MS/HDM/MV; 15% solids, 1.13 kg DM, 7.8 L solution/d); Medium Solids, Low DM, Low volume (MS/LDM/LV; 15% solids, 0.97 kg DM, 6.62 L solution/d); Low Solids, High DM, High volume (LS/HDM/HV; 12.6% solids, 1.13 kg DM, 9.2 L solution/d). Days 1–7, calves were offered the same % solids and 72% of MR DM stated above, with volume amounts adjusted accordingly. Calves were fed MR twice per day. Offering of MR was reduced by half, and calves fed once per d, during the last wk. Calf starter (22% crude protein, as fed basis) was fed ad libitum throughout this 49 d trial. Data were analyzed by Mixed Procedures of SAS. While there were no statistical differences (*P* > 0.05) in total BW gain, starter feed intake, or feed:gain, calves fed the MS/LDM/LV diet were numerically lower in total BW gain and numerically higher in starter feed intake when compared with calves on all other treatments. When considering offering a more dilute MR solution, it is important to deliver the same amount of MR DM to calves by offering more MR solution to support adequate growth of calves.

Table 1.

Item ¹	MR Diet				SE
	HS/HDM/ LV	MS/HDM/ MV	MS/LDM/ LV	LS/HDM/ HV	
BW gain, kg	33.1	34.0	31.0	33.4	1.09
MR intake (DM), kg	46.3 ^a	47.9 ^b	40.8 ^c	47.2 ^{ab}	0.380
Starter intake (DM), kg	19.8	19.4	21.1	18.8	1.29
Feed:Gain	2.05	2.00	2.01	2.01	0.040

^{a-c}Means in the same row not followed by a common letter differ (*P* < 0.05).

Key Words: calf, milk replacer, dilution

T278 The effect of varying fatty acid profile on growth and performance of calves fed milk replacer. B. L. Miller*, T. J. Earleywine, W. S. Bowen Yoho, and T. E. Johnson, *Land O' Lakes, Inc., Webster City, IA*.

In 2 separate trials, the growth and performance of calves fed milk replacer (MR) varying in protein level, fat level, and fatty acid profile were examined. Thirty-five (35) and 67 (67) 3- to 10-d-old Holstein bull calves with average initial weights of 46.6 kg (SD = 2.83 kg) and 47.9 kg (SD = 2.79 kg) were shipped from Wisconsin to the Land O' Lakes Research Facility for trials 1 and 2, respectively. Calves were randomly assigned according to body weight (BW) and blood gamma globulin to their respective MR diet offered in a 17.6% solids solution. Calves on trial 1 were assigned to 1 of 2 MR diets: 28% crude protein (CP), 20% fat with lard as the primary fat source; 27% CP, 10% fat with medium-chain triglycerides (MCT) as the primary fat source. Calves on trial 2 were assigned to 1 of 3 diets: 28% CP, 20% fat with lard as the primary fat source; 27% CP, 10% fat with MCT as the primary fat source; 26% CP, 10% fat with MCT as the primary fat source. Calves were fed to provide 816 g DM/d during d 1–7, and 1135 g DM/d during d 8–42, in 2 feedings at 0600 h and 1515 h. Calves were offered 567.5 g in one feeding at 0600 h during the last week. Calf starter (22% CP, as fed basis) was fed ad libitum throughout these 49 d trials. Data were analyzed by Mixed Procedures of SAS. For trial 1, calves fed a 28:20 MR with lard as the primary fat source were inferior ($P < 0.05$) in starter feed intake, MR consumption ($P < 0.05$), and body volume gain ($P < 0.05$), and tended ($P = 0.14$) to be inferior in total weight gain, compared with calves fed a 27:10 MR with MCT as the primary fat source. For trial 2, total weight gain did not differ among treatments. Calves fed a 28:20 MR were inferior ($P < 0.05$) in starter feed intake to calves fed a MR with lower CP and fat (26:10 and 27:10). Calves fed a 28:20 MR were superior in feed:gain when compared with calves fed the 26:10 MR, but did not differ from calves fed the 27:10 MR. Milk replacers with a modified fatty acid profile may allow for a reduction in protein and fat levels without negatively affecting growth and performance.

Key Words: calf, milk replacer, fatty acid

T279 Efficiency of IgG absorption in fresh or pasteurized colostrum of various qualities. S. L. Gelsinger*, C. M. Jones, and A. J. Heinrichs, *The Pennsylvania State University, State College*.

Previous data show improved IgG absorption in calves when fed pasteurized colostrum. However, this has not been compared using colostrum of very low or very high quality. This study was conducted to investigate this phenomena using colostrum of various qualities. Colostrum was sorted based on colostrometer measurement. This process was completed in summers of 2011 and 2012, and sorted colostrum was pooled to create 6 unique batches. Half of each batch was rebottled to be fed without heat treatment. The second half of each batch was heated to 60°C for 30 min, then subsequently cooled and bottled. All colostrum was frozen until fed. Colostrum treatments were analyzed for standard plate count, coliforms, non-coliform gram-negative bacteria, IgG1, and IgG2. Plasma samples were collected from 145 calves 48 h after birth and analyzed for IgG1, IgG2, total protein, and hematocrit. All IgG analysis was done using a bovine IgG1 or IgG2 ELISA and values were combined to calculate total IgG and apparent efficiency of absorption (AEA). Heat-treatment significantly reduced all types of bacteria. Colostral total IgG concentrations were 83.5, 89.7; 66.1, 52.4; 45.2, and 32.0 in the high, mid-range, and low batches from 2011, 2012, respectively. Plasma IgG levels and AEA were analyzed using Mixed procedure in SAS. Sex of calf, colostrum batch, treatment and batch by treatment interaction were included as fixed effects and calf within treatment was included

as a random effect. As expected, calves fed colostrum containing more IgG attained higher plasma IgG1 and IgG2 concentrations at 48 h ($P < 0.05$). Heat treatment of colostrum increased plasma IgG ($P < 0.05$) and tended to increase AEA. Female calves tended to have greater total IgG concentrations than male calves ($P = 0.05$). Results of this study suggest that heat-treatment of colostrum increases absorption of IgG in colostrum of various qualities including very high and very low quality.

Key Words: colostrum, heat-treatment, calf

T280 Performance of crossbred Holstein bull and heifer calves slaughtered 8-month old. M. Vestergaard*¹, P. Spleth², A. Mikkelson³, C. F. Børsting³, and M. Kargo^{1,2}, ¹*Aarhus University, Foulum, Denmark*, ²*Knowledge Centre Agriculture, Aarhus, Denmark*, ³*Cattle Research Centre, Tjele, Denmark*.

Most newborn bull calves of the Holstein (HOL) dairy breed in Denmark are raised intensively at specialized units and harvested at either 10 or 12–13 mo of age as young bulls. To be sold as veal in EU, the calf needs to be harvested before 8 mo. The market for rosé veal in EU requests a higher carcass conformation score (>4.5) than HOL bull calves can match. Use of sexed semen to produce HOL heifer calves on the genetically best cows allows for crossbreeding with beef breeds. The objective was to investigate if use of crossbreeding will produce offspring that can match the market requirement for rosé veal. A total of 12 purebred HOL bull calves (HOL), 12 beef × HOL bull (BULX) and 12 beef × HOL heifer (HEIX) calves were purchased at 4 wk of age. Two sires were used; one Limousine and one Belgium Blue (6 calves per crossbreeding group). Calves were fed milk replacer (850 g/d), grass hay and concentrate until weaning at 8 wk of age, and then gradually changed to a high-energy TMR based on concentrate pellets, corn-cob silage (35% of DM in TMR), ground barley, sugar beet pulp, and soybean and canola meal fed ad libitum until slaughter at 8 mo. The concentrate pellets (1.4 kg/calf/d) were removed from the TMR at 200 kg BW. Individual feed intake was recorded from 4 to 8 mo. Energy intake was not different between trt groups. At 4 mo, HOL, BULX and HEIX weighed 142, 154 and 140 kg (n.s.), ADG from 4 to 8 mo was 1.50, 1.68 and 1.46 kg/d ($P < 0.001$), BW at slaughter was 330, 368 and 323 kg ($P < 0.001$), and FCE was 4.2, 4.0 and 4.4 Scandinavian Feeding Units (= 7.89 MJ NEg) per kg gain for HOL, BULX and HEIX, respectively ($P < 0.02$). Dressing percentage increased from 51.3 in HOL to 55.5 and 52.8 in BULX and HEIX, respectively, leading to carcass weights of 162, 196 and 164 kg with conformation scores of 3.5, 6.5 and 5.5, respectively (both $P < 0.001$). No HOL but all 12 BULX and 11 out of 12 HEIX passed the 4.5 conformation score criteria. It is concluded that both crossbred male and female offspring of HOL cows can be utilized for rosé veal production in EU.

Key Words: veal, crossbreeding, growth

T281 Comparison of two nutritional programs from birth to 84 d of age in Holstein steers: Body composition, body weight, and stature. K. M. Daniels*¹, K. M. O'Diam¹, C. J. O'Diam¹, T. J. Earleywine², H. C. Puch³, B. L. Miller³, and J. A. Davidson³, ¹*Department of Animal Sciences, Ohio Agricultural Research and Development Center, The Ohio State University, Wooster*, ²*Land O'Lakes Animal Milk Products Co., Shoreview, MN*, ³*Purina Animal Nutrition Center, Gray Summit, MO*.

To compare effects of 2 nutritional programs on body composition, BW, and stature in dairy calves from 0 to 84 d of age, Holstein steers (n = 12) were assigned to either conventional (Con) or full potential

(FP) feeding and were slaughtered at 28, 56, or 84 d of age. Con were fed 454 g DM/d of a 20:20 milk replacer (MR) and 18% CP starter. FP were fed 818 g DM/d of a 28:20 MR followed by increased feeding rate to 1136 g DM/d at d 10 of age and 22% CP starter. MR was offered twice daily from 0 to 44 d of age; calves were weaned (d 45) with 50% reduction in MR DM for 6 d. Starter was offered ad libitum from 0 to 84 d of age. Hip height, BW, body length and heart girth measurements were obtained every 2 wk. At slaughter, animals were processed into: carcass; head, hide, feet, and tail (HHFT); blood; and total viscera. Body composition (water, protein, lipid) was estimated by analysis of 9–11th rib sections. All data were analyzed with a mixed model; weekly data were analyzed with repeated measures. Regardless of age, FP weighed more, were taller, longer, and had larger heart girths than Con. Estimated carcass composition averaged 72.3% water, 18.7% protein,

and 6.7% lipid. Regardless of age, body protein content tended to be greater (0.5%) in FP ($P = 0.09$). At 28 d of age, lipid content was 1.0% greater in FP, whereas at 84 d of age Con had 2.5% more lipid than FP ($P = 0.04$). Water content was not affected by diet, but decreased with increasing age ($P = 0.01$). FP tended to have greater protein:fat than Con, which is indicative of better lean gain (3.2 vs. 2.2; $P = 0.07$). As calves aged, percentage of final BW occupied by the carcass decreased ($P = 0.03$), whereas percentage occupied by viscera increased ($P = 0.01$). Nutritional program did not affect percentage of final BW occupied by: carcass, HHFT, blood, or total viscera. These averaged 53.8, 15.1, 5.2, and 25.9%, respectively. FP resulted in heavier and larger framed calves with fairly similar body composition as Con.

Key Words: dairy calf, body composition, nutrition