

## Ruminant Nutrition: Calves and Heifers

**T337 Interaction of breed and quantity of milk replacer on the performance of dairy calves.** C. J. Cobb\* and M. A. Ballou, *Department of Animal and Food Sciences, Texas Tech University, Lubbock.*

Objective was to determine the influence of breed and quantity of milk replacer fed on the performance of dairy calves. Forty-two bull calves (n = 20 Holstein and n = 22 Jersey, 2 ± 1 d old) in a 2 × 2 factorial arrangement were observed through 11 weeks of age. Holstein and Jersey calves on the lower plane of nutrition were fed a 20% protein and 20% fat milk replacer at a rate of 454 g / d. Holstein calves on the higher plane of nutrition were fed a 28% protein and 20% fat milk replacer at a rate of 810 and 1,180 g / d for wk 1 and wk 2 – 6, respectively. Jersey calves on the higher plane of nutrition were fed a 28% protein and 25% fat milk replacer at a rate of 568 and 680 g / d for wk 1 and wk 2 – 6, respectively. At wk 7 all milk intakes were reduced to 50% to stimulate starter consumption. Calves were weaned when consuming 900 g/d of starter. There were breed × plane of nutrition × time interactions ( $P < 0.01$ ) for milk refusal, starter intake, and total energy intake. Holstein calves fed the lower plane of nutrition had greater starter intakes from wk 4 through wk 8 than Holsteins fed the higher plane of nutrition. Plane of nutrition did not influence starter intake in Jersey calves. Calves fed the higher planes of nutrition had greater total energy intakes before weaning; however, after reducing milk intakes at wk 7 there was no difference within breed. There was an interaction of plane of nutrition and time ( $P < 0.01$ ) on average daily gain; whereas calves fed the higher planes of nutrition had greater gains from wk 1 to 6, but were not different from the calves fed the lower planes of nutrition from wk 7 to 11. Utilization of energy for body weight gain was greater for calves fed higher planes of nutrition ( $P < 0.01$ ) and Holsteins ( $P < 0.02$ ) from wk 1 to 6; however, from wk 7 to 11 the opposite was observed for plane of nutrition ( $P < 0.05$ ) and breed ( $P < 0.01$ ). These data indicate under the current higher plane of milk feeding schemes both Holstein and Jersey calves performed well; however, the amount of milk replacer fed to Jersey calves may be able to be increased during the pre-weaning period.

**Key Words:** breed, calf, performance

**T338 Evaluation of mannanoligosaccharides route of administration for dairy calves: Performance and rumen development.** J. T. Silva<sup>1,2</sup>, L. S. Ferreira<sup>1,2</sup>, and C. M. M. Bittar<sup>1,2</sup>, <sup>1</sup>University of Sao Paulo/ESALQ, Piracicaba, SP, Brazil, <sup>2</sup>CNPq, Brasilia, DF, Brazil.

The objective of this study was to evaluate the route of administration of mannanoligosaccharides (MOS) for dairy calves and its effects on performance and plasma parameters indicative of rumen development. Following birth, 24 male Holstein calves were used in a completely randomized design and assigned to the following treatments: 1) Control; 2) MOS (4 g/d Bio-Mos, Alltech Biotech.) via starter feed (MOSF); 3) MOS (4 g/d Bio-Mos, Alltech Biotech.) via milk replacer (MOSR). The animals were housed in individual hutches, with free access to water, and fed 4L/d of milk replacer (18.5% CP, 22.5% fat, 12.5% solids; Natimilk, Auster Animal Nutrition) until weaning at 6 weeks; calves also received a 23% CP starter feed ad libitum. Fecal scores were evaluated daily. Calves were weighted and growth measurements and blood samples for glucose, urea-N (PUN) and  $\beta$ -hydroxybutyrate (BHBA) were taken weekly until the eighth week of age. There was no significant ( $P > 0.05$ ) effect of treatment or treatment × age interaction for average starter feed intake (737.4; 842.6; 798.6 g DM/d for C, MOSF and MOSM, respectively), weight gain (352.2; 411.3; 409.6 g/d for C, MOSF and MOSM, respectively) or body growth (heart girth: 1.63; 1.74; 1.75 cm/week;

hip width: 0.43; 0.4; 0.36 cm/week for C, MOSF and MOSM, respectively). However, there was an age significant effect for all parameters ( $P < 0.0001$ ). Fecal scores were not affected by treatments; animals presented scores considered as diarrhea ( $>2.0$ ) only during the second week of life. Plasma concentration of glucose (81.4; 82.7; 86.7 mg/dL for C, MOSF and MOSM, respectively), PUN (13.7; 14.6; 14.0 mg/dL for C, MOSF and MOSM, respectively) or BHBA (0.203; 0.177; 0.163 mmol/L for C, MOSF and MOSM, respectively) were also not affected ( $P > 0.05$ ) by treatment or the interaction treatment × age. However, PUN and BHBA concentrations were significant increased with age ( $P < 0.05$ ), suggesting adequate rumen development. For the general and nutritional management imposed, there were no benefits of providing MOS via liquid or solid diet. Supported by FAPESP.

**Key Words:** additives, early weaning, fecal score

**T339 Impact of solids level of colostrum replacer formulations on immunoglobulin absorption in calves.** J. M. Campbell<sup>\*1</sup>, J. C. Gawthrop<sup>2</sup>, A. W. Riad<sup>2</sup>, L. E. Russell<sup>1</sup>, J. D. Crenshaw<sup>1</sup>, and J. Q. Quigley<sup>1</sup>, <sup>1</sup>APC, Inc., Ankeny, IA, <sup>2</sup>CalfCare, North Manchester, IN.

The objective was to determine if varying level of solids in a single feeding of colostrum replacer (CR) containing IgG derived from bovine serum fractions affected 24-h serum IgG, serum total protein, and the ability of calves to achieve adequate passive transfer. Forty-eight heifer or bull calves were randomly assigned to 1 of 4 treatments that included receiving a single feeding of CR containing 155 g of IgG reconstituted to 17.4, 20.2, 24.1, or 29.7% solids. Sex was equalized among treatments. All CR were blended, individually packaged, and irradiated before feeding. Colostrum replacers were reconstituted in warm water, mixed using a hand blender, and fed with an esophageal feeder at 1 h of age. Acquisition of passive immunity was assessed by measuring 24-h serum IgG, serum total protein, apparent efficiency of absorption (AEA) of IgG, and the ability to prevent failure of passive transfer (FPT). Data were analyzed as a completely randomized design with BW as a covariate when appropriate. Percentage of calves with FPT was analyzed by chi-squared analysis. Linear contrasts were used to produce linear analysis. As level of solids of the blended CR increased from 17.4 to 29.7%, there was a tendency ( $P < 0.10$ ) for increased 24-h serum IgG, while serum total protein was increased ( $P < 0.05$ ). No treatment differences ( $P > 0.10$ ) were noted in AEA or percent FPT. In conclusion, a range of solids level from 17.4 to 29.7% offered in a single feeding of CR containing 155 g IgG from bovine serum fractions can be fed to calves without impacting AEA or FPT.

**Key Words:** calves, immunoglobulin, colostrum replacer

**T340 Effect of yeast  $\beta$ -glucan and antibiotics on growth and intestinal microflora in early-weaning calves.** Y. Zhou, Q. Diao\*, Y. Tu, and Q. Yun, *Feed Research Institute, Chinese Academy of Agricultural Sciences, Beijing, China.*

This experiment was conducted to investigate the effect of yeast  $\beta$ -glucan and bacitracin zinc on growth performance and intestinal microflora in rectum of early-weaning calves. Twenty neonatal healthy Holstein male calves were randomly allotted to 4 treatments, each treatment contained 5 replicates with one calf per replicate. All calves were fed with diets supplemented with 0 (Treatment A), 75mg/kg yeast  $\beta$ -glucan (Treatment B and C), 60mg/kg bacitracin zinc (Treatment D). The experiment lasted

for 28 d. On d 21, calves of Treatment A, B and D were challenged orally with *Escherichia coli* (O141:K99). Average daily feed intake (ADFI), average daily gain (ADG) and intestinal tract bacterial communities were determined. Comparing with Treatment A, the ADG of calves in Treatment B increased by 26.17% and 24.93% in the 2 phases before the *Escherichia coli* challenged ( $P < 0.05$ ), the ADG of calves in Treatment B and D increased by 30.38% and 30.81% after the *Escherichia coli* challenged ( $P < 0.05$ ). As for the F/G, which in Treatment B and D were significantly lower than that in Treatment A ( $P < 0.05$ ). The amount of *Escherichia coli* in rectum was rapidly increased after the challenge, compared with Treatment A, the amount of *Escherichia coli* in rectum at 12h and 24h in Treatment B and D were significantly decreased ( $P < 0.05$ ), and the amount of *Lactobacillus* was significantly decreased in the Treatment D ( $P < 0.05$ ). PCR-DGGE of 16S rDNA was used to investigate the similarity index, the band number in Treatment C was significant higher than that in Treatment A and D ( $P < 0.05$ ). The degree of similarities of treatments ranged from 50% to 75%. According to the results,  $\beta$ -glucan could improve the growth of calves and adjust the structure of intestinal microflora, thus using  $\beta$ -glucan in calves feed may decreased the usage of antibiotics.

**Key Words:** calves, yeast  $\beta$ -glucan, intestinal microflora

**T341 Effects of forage quality traits and access to calf starter on selection between forages in milk-fed calves.** N. B. Kristensen\*, M. R. Weisbjerg, and M. Vestergaard, Aarhus University, Tjele, Denmark.

The present study aimed to investigate how milk-fed calves selected among 4 different grass-clover forages [1st cut silage (F1), 1st cut hay (F2), 2nd cut silage (F3), and 4th cut silage (F4)] and how access to calf starter affected forage selection. Sixteen Holstein bull calves ( $20 \pm 2$  d of age) offered 4.84 kg/d of skim-milk based milk-replacer (12.3% DM) were randomly allocated to no starter (CON) or ad libitum access to a barley-based calf starter (START). Calves were housed in individual pens and offered the 4 forages ad libitum. Calves were harvested at  $59 \pm 2$  d of age. Data on DMI and effect of starter on relative intake of individual forages were analyzed using the MIXED procedure in SAS by a model containing the fixed effects of block, time (day on trial), calf starter treatment, and the interaction between treatment and time. Calf by treatment was designated as a random effect and time considered a repeated measure. Friedman's test computed using the FREQ procedure was used to evaluate selection between forages. The forages had the following nutrient and fermentation product contents: DM ( $48 \pm 1$ ,  $88 \pm 1$ ,  $41 \pm 2$ , and  $47 \pm 2\%$ ), pH ( $5.33 \pm 0.13$ ,  $6.01 \pm 0.01$ ,  $4.23 \pm 0.01$ , and  $4.34 \pm 0.02$ ), DL-lactic acid ( $17 \pm 3$ , not detectable,  $69 \pm 2$ , and  $89 \pm 3$  g/kg DM), and acetic acid ( $4.6 \pm 0.7$ ,  $0.7 \pm 0.2$ ,  $14.6 \pm 0.6$ , and  $13.0 \pm 0.4$  g/kg DM) for F1, F2, F3, and F4, respectively. The intake of the individual forages differed ( $P < 0.01$ ) by source being  $57 \pm 3$ ,  $29 \pm 3$ ,  $4 \pm 1$ , and  $10 \pm 2\%$  of total forage intake for F1, F2, F3, and F4, respectively. Only intake of F4 was affected by calf starter (START:  $14 \pm 2\%$  vs. CON:  $6 \pm 2\%$ ,  $P = 0.02$ ). Forage intake tended ( $P = 0.09$ ) to be lower with START compared with CON, but total daily intake of calf starter + forage did not differ ( $P = 0.47$ ) between treatments (39 d average being 714 and  $771 \pm 55$  g DM/d for CON and START, respectively). Young milk-fed calves showed strong preference for lightly fermented grass-clover silage compared with both hay and more fermented silages, and the preference pattern was unaffected by the access to a barley-based calf starter.

**Key Words:** milk-fed calf, forage quality, feed intake

**T342 Performance of calves fed an all-milk or enzymatically modified plant protein containing milk replacer with and without a specific amino acid profile.** F. Soberon\*, A. M. Severy, and M. E. Van Amburgh, Cornell University, Ithaca, NY.

The most nutritionally effective milk replacers (MR) are produced from all milk proteins. Supplementing non-milk protein MR with amino acids (AA) might help overcome some of the performance limitations previously observed with the use of plant proteins. The objectives of this study were to compare the performance of calves fed an all-milk containing MR compared with a MR with 50% of the protein replaced by a proprietary formulation of enzymatically modified plant proteins (EPP) as formulated or with a specific AA profile calculated from body composition and efficiency of use data. Eighty calves (20 per treatment, TRT) were assigned, as they were born, by 24 h of age. Calves were blocked by birth weight and sex and assigned to one of 4 TRT: Control: all milk protein MR (Excelerate milk replacer, Milk Specialties Global (MSG), Carpentersville, IL); TRT 1: Control plus AA supplied by added crystalline AA; TRT 2: EPP containing MR formulated at 28% CP and 15% fat containing proprietary EPP protein (MSG, Carpentersville, IL) representing approx. 50% of the MR protein; TRT 3: EPP containing MR with supplemental AA. All MR were formulated to be isocaloric and isonitrogenous. Significance was declared at  $P < 0.05$ . Calves were fed only MR to d 28, offered grain from d 29 to 42, and then weaned in a step-down manner over 7 d. Growth and starter intakes were measured until d 70. ADG (kg/d) data are reported in the table. Calves fed the all-milk containing MR had greater ADG up to weaning ( $P < 0.05$ ) whereas post-weaning, increased starter intake in calves fed TRT 2 and 3 negated the growth advantage. Calves fed TRT 1 demonstrated greater hip height by d 49 compared with calves fed TRT 2 and 3 ( $P < 0.05$ ) and the difference remained until d 70. Prior to weaning performance was greater in calves fed milk protein base MR.

**Table 1.**

TRT	Day 28	Day 49	Day 70
Control, kg/d	0.72 <sup>a</sup>	0.74 <sup>a</sup>	0.73 <sup>a</sup>
TRT 1, kg/d	0.74 <sup>a</sup>	0.73 <sup>a</sup>	0.71 <sup>a</sup>
TRT 2, kg/d	0.63 <sup>b</sup>	0.66 <sup>b</sup>	0.70 <sup>a</sup>
TRT 3, kg/d	0.59 <sup>b</sup>	0.63 <sup>b</sup>	0.69 <sup>a</sup>

Values with different superscripts within column differ  $P < 0.05$ .

**Key Words:** amino acids, calves, milk replacer

**T343 Measurement of adaptive and innate immune function in calves raised under traditional and accelerated growth regimens.** B. A. Hengst\*, L. M. Nemec<sup>1</sup>, R. R. Rastani<sup>2</sup>, and T. F. Gressley<sup>1</sup>, <sup>1</sup>University of Delaware, Newark, <sup>2</sup>Milk Specialties Global Animal Nutrition, Carpentersville, IL.

This study compared conventional and accelerated milk replacer feeding regimens on growth, respiratory and digestive health, vaccination response, and neutrophil mRNA levels. Holstein calves (10 male and 5 female) were randomly assigned to a 10-wk study on d 2 of life. Treatments were control (CON; n = 8) and accelerated (ACC; n = 7) milk replacer feeding programs. CON calves were fed a 20% crude protein (CP)/20% fat milk replacer (Advance Calvita Supreme; Milk Specialties Global, Carpentersville, IL) at 1.25% birth body weight (BW) from wk 1 to 6 and 0.625% birth BW during wk 7. A 28.5% CP/15% fat milk replacer (Advance Excelerate; Milk Specialties Global, Carpentersville, IL) was fed to ACC calves at 1.5% birth BW during wk 1, 2% current BW from wk 2 to 6, and 1% current BW during wk 7. All calves were

given milk replacer twice daily during wk 1 to 6, once daily during wk 7, and were weaned completely during wk 8. Calf starter intake was measured daily through wk 8. BW and wither height were measured weekly. Fecal scores (1 = firm to 4 = liquid) and respiratory scores (1 = normal; 2 = abnormal) were recorded twice daily. Neutrophils were isolated from blood at wk 1, 3, 5 and 8. Quantitative PCR was used to measure neutrophil mRNA levels of 7 functionality genes including the adhesion factor *L-selectin* (CD62L). Adaptive immune function was measured by vaccinating calves against ovalbumin at wk 1, 3 and 5 and measuring anti-ovalbumin IgG production at wk 1, 3, 5 and 8. There was no treatment effect on wither height, respiratory score, or anti-ovalbumin IgG production. BW during wk 4 to 10 was greater for ACC than CON calves ( $P < 0.01$ ). Calf starter intake was greater for CON than ACC calves during wk 4 to 7 ( $P < 0.01$ ), with no difference during wk 8. CON calves had firmer feces than ACC calves (fecal score 1.4 vs. 1.7,  $P = 0.02$ ). Neutrophil *L-selectin* mRNA levels were 51% greater in ACC than CON calves ( $P = 0.03$ ). Feeding calves a 28.5% CP/15% fat milk replacer in an accelerated feeding regimen increased growth and may enhance innate immune function, as indicated by the increased neutrophil mRNA levels of *L-selectin*.

**Key Words:** dairy calf, immune function, milk replacer

**T344 Effects of hay intake on calves fed high volumes of milk.** M. A. Khan<sup>\*1</sup>, D. M. Weary<sup>1</sup>, D. M. Veira<sup>2</sup>, and M. A. G. von Keyserlingk<sup>1</sup>, <sup>1</sup>University of British Columbia, Vancouver, BC, Canada, <sup>2</sup>Agriculture and Agri-Food Canada, Agassiz BC, Canada.

Research to date has suggested that access to forage before weaning can limit rumen development in calves fed restricted amount of milk, but no research has addressed the role of forage on calves fed at higher planes of nutrition. This study compared performance and rumen development of calves provided high volumes of milk with and without access to hay. At d 3 of age, individually housed calves were randomly assigned to treatment (either ad libitum access to chopped grass hay or no forage; n=15 calves per treatment, 10 heifers and 5 bulls). All calves were provided ad libitum access to water and starter throughout the study. All calves were offered 8 L/d of milk from a nipple bottle from d 3 to 35, 4 L/d from d 36 to 53 and 2 L/d for the next 3 d before weaning at d 56. Solid feed intake and growth were monitored from d3 to d70. At d 70 males from both treatments were slaughtered and rumen pH and weight of ruminal contents with and without digesta measured. Overall DMI from solid feed did not differ between treatments before weaning. After weaning calves provided hay consumed less starter but more total DM (starter plus hay) than calves that had no access to forage. Over the experimental period (d 4 to 70), calves fed hay gained approximately 6 kg more than did control calves ( $58.14 \pm 1.83$  vs.  $52.04 \pm 2.03$  kg, respectively;  $P < 0.05$ ). Hip and wither height, heart girth and body barrel at d 35, 56 and 70 did not differ between treatments. Rumen and reticulum weights with ( $7.99 \pm 0.69$  vs.  $12.77 \pm 1.29$  kg;  $P < 0.05$ ) and without digesta ( $1.60 \pm 0.09$  vs.  $1.89 \pm 0.05$  kg;  $P < 0.05$ ) were heavier in calves fed hay. Mean rumen pH was higher in calves fed hay compared with those fed no forage ( $5.49 \pm 0.08$  vs.  $5.06 \pm 0.04$ ;  $P < 0.002$ ). In conclusion, providing hay before weaning resulted in increased weight gain, rumen weight and rumen pH in calves fed high volumes of milk.

**Key Words:** solid feed, forage, weaning

**T345 Influence of milk replacer feeding program on pre- and post-weaning performance and health of dairy calves.** D. Carlson<sup>\*1</sup>, B. Ziegler<sup>2</sup>, D. Schimek<sup>2</sup>, M. Raeth-Knight<sup>3</sup>, G. Golombeski<sup>3</sup>, J. Linn<sup>3</sup>, D. Ziegler<sup>4</sup>, and H. Chester-Jones<sup>4</sup>, <sup>1</sup>Milk Products LLC, Chilton,

WI, <sup>2</sup>Hubbard Feeds, Inc., Mankato, MN, <sup>3</sup>University of Minnesota, St. Paul, <sup>4</sup>University of Minnesota, Southern Research and Outreach Center, Waseca.

Holstein heifer calves (n = 100, 2–4 d of age) were assigned randomly to 1 of 4 milk replacer (MR) programs to evaluate the effect of MR feeding rate and crude protein (CP) intake on calf performance and health during pre- (d 1–42) and post-weaning (d 43–56) periods. Treatments (TRT) were: 1) 20% CP, 20% fat MR fed at 0.57 kg/d (as-fed powder weight) from d 1–35 and 0.28 kg/d from d 36–42 (CON); 2) 20% CP, 20% fat MR fed at 0.68 kg/d from d 1–14, 0.45 kg/d from d 15–35, and 0.23 kg/d from d 36–42 (TRT 2); 3) 24% CP, 18% fat MR fed at 0.68 kg/d from d 1–14, 20% CP, 20% fat MR fed at 0.45 kg/d from d 15–35 and 0.23 kg/d from d 36–42 (TRT 3), and 4) 28% CP, 16% fat MR fed at 0.68 kg/d from d 1–14, 20% CP, 20% fat MR fed at 0.45 kg/d from d 15–35 and 0.23 kg/d from d 36–42 (TRT 4). Calves were fed MR twice daily from d 1–35, and once daily from d 36–42. Calves were housed in individual calf pens within a naturally ventilated barn with curtain sidewalls, were fed a texturized calf starter (18% CP), and had access to fresh water. Average daily gain (ADG) during d 1–14 was greater ( $P < 0.05$ ) for TRT 2, 3, and 4 versus CON, and TRT 4 had greater ( $P < 0.05$ ) ADG than TRT 2 and 3. For d 15–28, ADG was lower ( $P < 0.05$ ) for TRT 2, 3, and 4 compared with CON. Milk replacer feeding program did not affect ADG from d 29–56, 1–42, or 1–56. Calf starter intake was similar for d 1–14, whereas TRT 4 had greater ( $P < 0.05$ ) starter intake than CON with TRT 2 and 3 being intermediate for d 15–28. For d 29–42, TRT 3 and 4 had greater ( $P < 0.05$ ) starter intake than CON with TRT 2 intermediate. Health parameters did not differ among groups. Under the conditions of this study, increasing MR feeding rate and feeding 28% CP MR resulted in greater ADG from d 1–14, but reducing MR feeding rate and CP intake on d 14 resulted in depressed ADG from d 15–28.

**Key Words:** calves, milk replacer, feeding rate

**T346 The effect of feeding dairy heifers diets with and without supplemental phosphorus for 18 months on growth, reproductive efficiency and lactation performance.** D. W. Bjelland<sup>\*1</sup>, N. M. Esser<sup>1</sup>, K. A. Weigel<sup>1</sup>, P. C. Hoffman<sup>1</sup>, and W. K. Coblentz<sup>2</sup>, <sup>1</sup>University of Wisconsin, Madison, <sup>2</sup>USDA-ARS Dairy Forage Research Center, Marshfield, WI.

The phosphorous (P) requirements for dairy heifers (0.20–0.35%) and endogenous levels (0.20–35%) of P in feeds fed to dairy heifers are similar, suggesting that the need for supplemental P in dairy heifer diets may be minimal. Because long-term studies are unavailable, 183 Holstein heifers and 182 backcross Holstein × Jersey heifers were fed diets with (SP = 0.38% of dry matter (DM)) and without (NP = 0.28% of DM) supplemental phosphorus from 4 to 22 mo of age in a replicated pen design. Heifers were evaluated for body weight (BW), external bone/frame growth, dystocia, calf BW, reproductive efficiency, and first lactation performance. Data were analyzed using a mixed model with effects of season of birth, age of dam, pen number as a heifer, sire, sire birth year, and days in milk. No breed × diet interactions were observed. Heifers fed NP had similar average daily gain from 170 to 410 (0.86 vs. 0.83 kg/d) and 410–650 (0.85 vs. 0.86 kg/d) d of age as compared with heifers fed SP. At 22 mo of age, heifers fed NP were wider at the hip but did not differ in BW, hip height, body length, heart girth, cannon bone circumference or pelvic area as compared with heifers fed SP. As heifers, services per conception (1.45 vs. 1.39), age at pregnancy (451 vs. 452 d), and age at first calving (726 vs. 727 d) were not different between heifers fed NP or SP. At parturition, heifers fed NP or SP had similar dystocia scores and calves were similar in BW. Complete first



lactation data (305 d) were available for 333 primiparous cows, and cows fed NP as heifers produced similar milk (8702 vs. 8714 kg), fat (330 vs. 328 kg) and protein (274 vs. 277 kg) as cows fed SP as heifers. Days open (152 vs. 160 d), days in milk at first breeding (76 vs. 76 d), and services per conception (1.82 vs. 1.85) were also similar for primiparous cows fed NP or SP as heifers. Data suggest there was no growth, reproductive or lactation benefit to feeding dairy heifers diets containing 0.38% P as compared with 0.28% P.

**Key Words:** dairy heifers, phosphorous, lactation performance

**T347 The effect of *Megasphaera elsdenii* NCIMB 41125 (Me) on performance of pre-weaned dairy calves.** F. M. Hagg<sup>\*1</sup>, C. M. Muya<sup>2</sup>, and P. H. Henning<sup>1</sup>, <sup>1</sup>MS Biotech, Centurion, South Africa, <sup>2</sup>ARC-Irene, Centurion, South Africa.

Dairy farmers often aim to wean calves as early as possible. They are usually weaned upon reaching a target starter diet intake, so that rapid increase in feed intake becomes an important attribute. Field observations suggest that dosing pre-weaned calves with Me, as a DFM, has a positive effect on their well-being and performance. The objective of this study was to determine if dosing calves with Me could reduce weaning time by increasing the rate at which intake of dry feed increases in pre-weaned calves. Forty pre-weaned Holstein dairy calves entered the trial 14 d after birth, as they became available. The first calf was randomly allocated to one of the 2 treatments and all subsequent calves were alternately allocated to one or the other treatment. Me-treated calves received a single oral dose of Me (50 mL, 10<sup>8</sup> cfu/mL) on d 14. Control calves received no Me but were treated similar in all other respects. Commercial calf starter (18% CP) was fed ad lib while milk supply was restricted. Water was supplied ad lib. Feed, water and milk intake were measured daily while calves were weighed once per week. Calves were weaned upon reaching a DMI of 1.0 kg/d. Four additional calves, 2 each for treatment and control, and handled similar to the others, were slaughtered 72 h after dosing for rumen and colon samples to measure Me using Q-PCR. Me-treated calves had a greater ( $P = 0.11$ ) rate of increase in DMI (37.0 vs. 28.6 g/d) and greater ( $P = 0.02$ ) water intake (3.2 vs. 2.4 kg/d). Milk intake (3.46 and 3.51 kg/d) and ADG (480 and 437 g/d), for Me and control respectively, did not differ ( $P = 0.63$  and  $P = 0.44$ ) significantly. Me treatment decreased ( $P = 0.21$ ) the number of days from birth to weaning (40 d vs. 44 d) and Me-treated calves had 67% less mortalities than the untreated calves. Me-treated calves had greater Me levels than controls in both rumen ( $1.4 \times 10^9$  vs.  $1.6 \times 10^6$  genomes/mL) and colon ( $1.4 \times 10^7$  vs.  $<1 \times 10^3$  genomes/mL). These results suggest that dosing calves with *Megasphaera elsdenii* NCIMB 41125 establish the organism in the GIT and may benefit calves through increased DMI and earlier weaning.

**Key Words:** *Megasphaera elsdenii*, dairy calves, early weaning

**T348 Influence of nonmedicated additives as alternatives to antibiotics on calf health, growth, and intestinal development.** S. I. Kehoe<sup>\*1</sup>, D. B. Carlson<sup>2</sup>, and E. O. Hardwick<sup>1</sup>, <sup>1</sup>University of Wisconsin-River Falls, River Falls, <sup>2</sup>Milk Products, Inc., Chilton, WI.

Many producers use medicated milk replacers to prevent scours in dairy calves, however, a commonly added level of neomycin and oxytetracycline is no longer approved. The objective of this trial was to determine whether a milk replacer with a blend of nonmedicated additives would have similar benefits to a milk replacer with added neomycin and oxytetracycline. Twelve bull calves were purchased from a local farm 3 separate times and were fed one of 3 treatments for a 5 week period. All treatments used a 20% fat, 20% crude protein milk replacer with

either no additives (C), a blend of nonmedicated additives (NM; animal plasma, yeast cell wall extracts, inulin, and a direct-fed microbial), or neomycin and oxytetracycline (MED; 400 g/ton of neomycin; 200 g/ton of oxytetracycline). Two calves from each treatment were slaughtered during their second day of scouring and intestinal tissues were collected for morphological analyses. The surviving calves were fed until 3 weeks of age when they were moved to indoor individual pens and grain starter was offered. Weekly growth parameters were recorded and blood was analyzed for blood urea nitrogen (BUN) and glucose concentrations. Results indicate there were no significant differences between treatments for BUN, glucose, and serum protein. Feed intake was also not significant (C 652.4g, NM 759.4g, MED 687.5 g) however, hematocrits were highest for C compared with NM and MED (65.9 vs. 57.5 and 56.3%, respectively;  $P < 0.005$ ). Fecal scores were significantly higher for C than NM and MED (1.9 vs. 1.5 and 1.5, for C, NM and MED, respectively). Intestinal weights and lengths were not significant except for colon weight which was lower for NM than for MED or C ( $P < 0.02$ ). Although not statistically analyzed, fecal results indicate C had the highest density of *E. coli*. Growth parameters were also not significant; however, heart girth was lower in C compared with NM and MED (32.7 vs. 33.1 and 33.5, respectively;  $P < 0.005$ ). These results indicate that nonmedicated additives may have some effect in reducing diarrhea and dehydration, and promoting some growth.

**Key Words:** calves, milk replacer, health

**T349 Pre- and post weaning performance and health of calves fed milk replacers and calf starters with or without yeast supplementation (Nupro) and growth performance from 9 to 25 weeks of age.** H. Chester-Jones<sup>\*1</sup>, J. Tricarico<sup>2</sup>, D. Ziegler<sup>1</sup>, K. Dawson<sup>2</sup>, P. Groenewegen<sup>2</sup>, M. Raeth-Knight<sup>3</sup>, and G. Golombeski<sup>3</sup>, <sup>1</sup>University of Minnesota Southern Research and Outreach Center, Waseca, <sup>2</sup>Alltech Inc., Nicholasville, KY <sup>3</sup>University of Minnesota Southern Research and Outreach Center, St. Paul.

One hundred seven (2- to 4-d-old) individually housed Holstein heifer calves ( $39.1 \pm 0.68$ kg) were randomly assigned to 1 of 4 treatments to evaluate the effect of supplementing natural yeast (NuPro; NP) in milk replacer (MR) and calf starter (CS) on performance and health pre- (d 1–42) and post-weaning (d 43–56). All calves were fed a 20:20 MR (CP:fat) containing 12.5% solids and an 18% CP starter. Nursery treatments were: 1) 0% NP in calf MR and CS (CON); 2) 5% NP in MR and 0% in CS (NPMR); 3) 0% NP in MR and 2.5% NP in CS (NPCS); and, 4) 5% NP in MR and 2.5% NP in CS (NPMRCS). Milk replacers for all treatments was fed at 0.57 kg/d (as-fed powder weight) twice daily from d 1 to 35 and at 0.28 kg/d 1X daily from d 36 to 42. Calf growth up to 25 wk of age was also monitored in all calves receiving the above nursery treatments when they were housed in group pens (7 calves/pen) and fed a common grower diet from 9 to 25 weeks of age. Pre-weaning ADG tended to be higher ( $P = 0.08$ ) for CON calves than those fed the other treatments. Post weaning gain was lowest for NPMR and NPMRCS calves ( $P < 0.05$ ). Overall 56 d ADG was highest for CON calves ( $P < 0.05$ ). There were no pre- weaning and overall 56 d differences in CS and total DMI. Pre-weaning feed/gain (FG) was higher for NPMR vs. NPMRCS calves ( $P = 0.04$ ). Post weaning FG was lower ( $P < 0.05$ ) for CON and NPMR vs. NPCS calves. There were no differences in pre-weaning scouring days across treatments. There were no effects of nursery feeding programs on calf growth when fed a common diet from 9 to 25 wk of age. Under the conditions of this study supplementing nursery programs with a natural yeast supplement did not enhance individual or group fed heifer calf performance.

**Key Words:** calf performance, feeds, yeast supplementation

**T350 Pre- and post weaning performance and health of calves fed milk replacers and calf starters with or without essential oils.** H. Chester-Jones<sup>\*1</sup>, T. Steiner<sup>2</sup>, M. Watkins<sup>3</sup>, D. Taylor<sup>3</sup>, D. Ziegler<sup>1</sup>, M. Raeth-Knight<sup>4</sup>, and G. Golombeski<sup>4</sup>, <sup>1</sup>University of Minnesota, Southern Research and Outreach Center, Waseca, <sup>2</sup>BIOMIN Holding GmbH, Herzogenburg, Austria, <sup>3</sup>BIOMIN America Inc., San Antonio, TX, <sup>4</sup>University of Minnesota, St. Paul.

One-hundred thirty (2- to 4-d-old) individually fed Holstein heifer calves ( $40 \pm 0.73$  kg BW) were randomly assigned to 1 of 5 treatments to evaluate the effect of supplementing essential oils (Biomim P.E.P.) in milk replacer (MR) and calf starter (CS) on performance and health pre-(d 1–42) and post-weaning (d 43–56). Treatments were: 1) Medicated MR and a 18% CP (as-fed) texturized calf starter with rumensin (0.033 mg/kg; CON); 2) Non-medicated MR and CS with no additives (NM); 3) Non-medicated MR with PEP (0.88 g/kg) and CS with no additives (NMPEP); 4) Non-medicated MR and CS with PEP (0.41 g/kg; CSPEP); and 5) Non-medicated MR and CS with PEP (MRCSPEP). A 20:20 (CP:fat) milk replacer containing 12.5% solids, was fed at 0.57 kg/d (as-fed powder weight) twice daily from d 1 to 35 and at 0.28 kg/d 1X daily from d 36 to 42. Pre-weaning ADG was higher ( $P < 0.05$ ) for CON and NMPEP calves vs. those fed NM and MRCSPEP. Post weaning ADG was higher ( $P < 0.05$ ) for CSPEP vs. CON and NM calves. Overall ADG was lower ( $P = 0.02$ ) for NM calves vs. NMPEP, CSPEP and MRCSPEP calves. Calves fed NMPEP had higher ( $P = 0.04$ ) overall ADG than MRCSPEP calves. Total calf starter and DMI for NMPEP calves tended to be higher vs. those fed NM ( $P < 0.07$ ) and MRCSPEP ( $P < 0.09$ ). There were no treatment differences in total DMI. Pre-weaning feed/gain (FG) was lowest for CON and NMPEP vs. other treatments. Post weaning FG was similar ( $P > 0.05$ ) across all treatments. There were no treatment differences in scouring days or health costs. In this study, feeding a non-medicated MR with PEP and a CS without additives resulted in similar calf performances compared with a medicated MR and CS with rumensin. There were no benefits of offering non-medicated MR without PEP and CS with PEP or a combination of non-medicated MR and CS with PEP.

**Key Words:** calf performance, milk replacer, calf starter

**T351 Pre- and post weaning performance and health of calves fed texturized calf starters with different levels of monensin and affect on growth from 9 to 25 weeks of age.** H. Chester-Jones<sup>\*1</sup>, B. Ziegler<sup>2</sup>, D. Schimek<sup>2</sup>, D. Ziegler<sup>1</sup>, M. Raeth-Knight<sup>3</sup>, G. Golombeski<sup>3</sup>, and J. Linn<sup>3</sup>, <sup>1</sup>University of Minnesota Southern Research and Outreach Center, Waseca, <sup>2</sup>Hubbard Feeds Inc., Mankato, MN, <sup>3</sup>University of Minnesota Southern Research and Outreach Center, St. Paul.

One-hundred twenty three (2- to 4-d-old) individually fed Holstein heifer calves ( $40.3 \pm 0.77$  kg) were randomly assigned to 1 of 4 treatments to evaluate pre- (d 1–42) and post weaning (d 43–56) calf performance and health when fed 18% CP (as-fed) texturized calf starters (CS) with varying monensin levels. All calves in the nursery were fed a medicated 20% fat:20% protein milk replacer at 0.284 kg in 1.99 L water (12.5% solids) 2X daily for the first 35 d and 1X daily from d 36 to weaning at 42 d. Calf starters were fed free choice from d 1 and calves had access to fresh water. The formulated CS monensin treatment levels were 1), none; 2), 33 mg/kg; 3), 49.5 mg/kg; and, 4) 66 mg/kg. Monensin level did not affect ( $P > 0.05$ ) pre- and post weaning ADG which averaged 0.69 kg/d for 56 d. Overall starter intake decreased linearly ( $P = 0.02$ ) with increasing dietary monensin. Feed/gain was similar ( $P < 0.05$ ) across CS fed (average 1.9 kg/kg gain). There were no health differences across treatments. Calves were transitioned to grower pens (7 heifers/pen) and performance was monitored from 9 to 25 wk of age. Calves

were limit-fed a common 16% CP grain mix containing monensin (42.9 mg/kg d1–84, and 71 mg/kg d 85–112) fed at 2.72 kg for 56 d then 2.27 kg for an additional 56 d with free choice hay. Overall 112 d ADG in the grower period linearly increased ( $P = 0.06$ ) for calves fed increasing monensin levels in the nursery. Under the conditions of this study increasing monensin levels in the CS during the nursery phase did not affect daily gain but starter intake decreased. Calves fed increasing levels of monensin in the nursery tended to show performance compensation when fed a common diet in grower pens.

**Key Words:** calf performance, calf starters, monensin levels

**T352 Effect on feed sorting of adding plain or flavored water to a TMR for heifers.** A. Mereu<sup>1</sup>, A. Puddu<sup>2</sup>, I. R. Ipharraguerre<sup>\*1</sup>, and A. Bach<sup>2,3</sup>, <sup>1</sup>Lucta SA, Barcelona, Spain, <sup>2</sup>IRTA-Ruminant Production, Caldes de Montbui, Spain, <sup>3</sup>ICREA, Barcelona, Spain.

The impact on feed sorting of adding plain or flavored water to a TMR was evaluated using 24 Holstein heifers ( $315 \pm 24$  kg of BW) in a replicated  $3 \times 3$  Latin square design with 14-d periods. Once daily, heifers were fed individually for ad libitum intake a TMR (16.5% CP, 33.8% NDF) composed of 40% ryegrass hay and 60% concentrate. Treatments resulted from the addition of plain (WET; 55.8% DM) or flavored water (FLAV; 53.7% DM) to the ryegrass hay of a control diet (DRY; 90.2% DM). A flavor combined with a sweetener (Luctarom SFS-R) was mixed with tap water and applied to the hay at 250 g/ton of diet. Dietary particle size distribution was measured with the Penn State Particle Separator determining 4 fractions (long, medium, short and fine) at 0, 6, 12 and 24 h after feeding during the last 2 d of each period. Data were analyzed using a mixed model with animal (period) treated as random variable and treatment, period and their interaction treated as fixed effects. There were no significant differences on DMI. Both ADG and G:F were numerically greater for FLAV (1.41 kg/d and 0.18, respectively) when compared with WET (1.19 kg/d and 0.15, respectively) and DRY (1.34 kg/d and 0.17, respectively). Six hours after feeding, FLAV heifers reduced ( $P < 0.05$ ) the preferential consumption of fine particles ( $< 1.18$  mm) compared with DRY and WET. At 24 h post-feeding, heifers in the DRY group consumed proportionally less ( $P < 0.05$ ) long particles ( $> 19$  mm) and tended ( $P < 0.15$ ) to consume a larger proportion of fine particles when compared with those receiving the WET and FLAV rations. Findings from this study indicate that plain or flavored water addition to the TMR can contribute to limit the sorting of long particles by heifers. Furthermore, flavor addition can enhance hay palatability and thereby minimize the preferential consumption of fine particles within the first 6 h post-feeding.

**Key Words:** sorting, palatability, flavor

**T353 Effect of including corn distillers dried grains in calf feeds.** F. X. Suarez-Mena<sup>\*1</sup>, A. J. Heinrichs<sup>1</sup>, T. M. Hill<sup>2</sup>, H. G. Bateman II<sup>2</sup>, J. M. Aldrich<sup>2</sup>, and R. L. Schlotterbeck<sup>2</sup>, <sup>1</sup>The Pennsylvania State University, University Park, <sup>2</sup>Nurture Calf Research, Proville North America, Lewisburg, OH.

A series of 5 trials were conducted to determine the effect of distillers dried grains with solubles (DG) in calf diets. Trial 1 compared 0 and 49% DG in 18% CP starters (as-fed basis) fed to calves initially 2 to 3 d old for 56 d. Digestibility was estimated during d 52 to 56 using chromic oxide. Trial 2 compared 0 and 39% DG in 16% CP growers fed to calves from 8 to 12 wk of age from 28 d. Trial 3 compared 0, 10, and 20% DG in 18% CP starters fed to calves initially 2 to 3 d old for 56 d. Trial 4 compared 0 and 20% DG in 16% CP growers fed to calves from 8 to 12 wk of age from 28 d. As DG increased in all the

experiments, ADF, NDF, and fat increased and calculated metabolizable energy (ME) was similar but not equalized. In Trials 1 and 3, calves (48 calves/trial) housed in individual pens were fed a 26% CP, 17% fat milk replacer powder and weaned at 28 d. Trials 2 and 4 used calves (48 calves per trial) housed in group pens (6 calves/pen) that had been weaned from 28 d before the trials start. Trial 5 (18 calves) had same treatments as Trial 3, with calves killed at 35 d to determine DG effects on rumen development. All trials were completely randomized designs. Calf was the experimental unit (EU) in Trials 1, 3 and 5, and pen was the EU in Trials 2 and 4. In Trial 1, ADG was 6% greater and dry matter digestibility was 10% greater ( $P < 0.05$ ) for calves 0% vs. 49% DG. In Trial 2, ADG (9%), feed efficiency (10%), and hip width change (19%) were greater ( $P < 0.05$ ) for calves 0% vs. 39% DG. In Trial 3, performance measures did not differ among starter treatments. Calf ADG were numerically 4% greater ( $P > 0.50$ ) in calves fed 0% vs. 10 or 20% DG. In Trial 4, ADG (4%), feed efficiency (5%), and hip width change (19%) were greater ( $P < 0.05$ ) for calves fed 0% vs. 20% DG. Thus, these results suggest that high levels of distillers in calf starters and growers reduce calves growth.

**Key Words:** corn distillers dried grains with solubles, calf digestion, rumen development

**T354 Determination of oro-sensorial preferences of protein ingredients in weaned calves.** C. Montoro<sup>\*1</sup>, I. Ipharraguerre<sup>2</sup>, and A. Bach<sup>1,3</sup>, <sup>1</sup>Ruminant Production, IRTA, Caldes de Montbui, Barcelona, Spain, <sup>2</sup>Lucta S.A., Barcelona, Spain, <sup>3</sup>ICREA, Barcelona, Spain.

The objective of this study was to determine oro-sensorial preferences among common protein feed ingredients used to manufacture calf starters. A total of 15 assays involving 160 calves were conducted to rank calf oro-sensorial preferences for wheat distillers dried grains (DDG), corn gluten meal (CGM), peas, rapeseed meal (RSM), soybean meal (SBM) and sunflower meal (SFM). To minimize the effect of feed texture, all ingredients were ground at 3 mm. In each assay, 20 naive calves were offered a choice ad libitum of 2 ingredients and feed consumption was monitored every 30 min for 6 h. Each group of calves was used in 2 different assays which were conducted 3 and 5 d after weaning. No calf was presented twice with the same ingredient. Oro-sensorial preferences were calculated as the mean difference in feed consumption every 30 min over a 6-h period. Feed preferences were determined using a mixed-effects model. The most preferred protein ingredients were soybean meal and DDG, whereas CGM was the least preferred. Soybean meal was the most preferred ingredient in all assays and consumption was clearly greater than for the others ingredients (Table 1). On the other hand, CGM was the least preferred ingredient in all assays. Results indicate that SBM and DDG should be the preferred protein sources and CGM should be avoided when formulating starters for calves.

**Table 1.** Ingredient (Ingr) dry matter intake (DMI) per assay (g/30 min)

Ingr 1	DMI 1	Ingr 2	DMI 2	P-value	Ingr 1	DMI 1	Ingr 2	DMI 2	P-value
DDG	67.77	CGM	11.54	<0.0001	CGM	5.71	PEA	78.02	<0.0001
DDG	53.73	PEA	40.90	0.138	CGM	2.06	SBM	159.38	<0.0001
DDG	4.06	SBM	157.17	<0.0001	CGM	2.08	RSM	20.33	<0.0001
DDG	59.04	SFM	29.13	<0.0001	CGM	3.21	SFM	145.08	<0.0001
DDG	49.60	RSM	13.98	<0.0001	PEA	2.31	SBM	63.08	<0.0001
RSM	1.83	SBM	93.04	<0.0001	PEA	8.10	RSM	10.06	0.570
RSM	1.90	SFM	29.08	<0.0001	PEA	12.79	SFM	15.19	0.703
SFM	26.08	SBM	150.50	<0.0001					

**Key Words:** palatability, preferences, intake

**T355 Effect of dietary supplementation of exogenous polysaccharide-degrading enzymes on blood metabolites and rumen fermentation and nutrient digestibility for Holstein heifers.** C. Y. Guo<sup>\*</sup>, Q. Y. Diao, N. F. Zhang, and Y. Tu, *Chinese Academy of Agricultural Sciences, Beijing, China.*

The objective of this job was to investigate the effect of supplementation poly-saccharide-degrading enzymes (EPDE) to TMR diets on their blood metabolites and rumen fermentation and nutrient digestibility for 12 weeks to 24 week Holstein heifers. The treatments were as follows: control (no EPDE), EPDE sprayed onto and mixed with the daily ration (EF, 20.0 g/d). Feed samples were collected once weekly, feed refusals and fecal samples were collected twice weekly. Ruminal fluid was collected from rumen tube. Plasma was collected by centrifugation at 1800xg for 30 min and stored at -20°C until it was analyzed. We chose to measure serum total protein and plasma urea nitrogen (PUN) to evaluate protein metabolism and triglyceride concentrations as indices for fat metabolism. Data were analyzed using the general linear model ANOVA procedures of SAS. The results show that enzyme treatment increased the concentration of soluble reducing sugars ( $P < 0.05$ ) and decreased NDF content ( $P < 0.05$ ) in the treated feed. Compared with control, ruminal fermentation was affected by EF ( $P < 0.05$ ), ruminal VFA patterns were changed. Ruminal carboxymethylcellulase (CMCase) and xylanase activities were not affected by treatment. In a digestion trial, heifers were fed EPDE 20g/heifers per day, and total faces were collected. Compared with control, enzyme treatment increased the apparent digestion of DM ( $P < 0.05$ ), acid detergent fiber ( $P < 0.05$ ). Crude protein in the diet tend to increase numerically. The results of evaluate lipid metabolism and protein metabolism showed that add EPDE to diet have no significant effect on PUN, total albumin, total cholesterol, triglyceride. But numerically, supplement of EPDE decreased total albumin and total cholesterol in plasma and increased the concentrate of blood glucose in plasma. In conclusion, adding EPDE to diets could improve feed nutrition digestibility, especially enhance NDF and ADF digestibility (DM basis), change ruminal fermentation, and have no effects on lipid metabolism and protein metabolism.

**Key Words:** exogenous enzymes, Holstein heifers, rumen fermentation

**T356 Relationships between chewing behavior, digestibility and digesta kinetics parameters in calves fed restricted and ad libitum levels of oat hay.** R. S. Dias<sup>1</sup>, H. O. Patino<sup>2</sup>, S. López<sup>3</sup>, E. Prates<sup>2</sup>, K. Swanson<sup>\*1</sup>, and J. France<sup>1</sup>, <sup>1</sup>University of Guelph, Guelph, Ontario, Canada, <sup>2</sup>Universidade Federal do Rio Grande do Sul, Porto Alegre, Rio Grande do Sul, Brazil, <sup>3</sup>IGM, CSIC-Universidad de León, León, Spain.

The objective of this study was to elucidate relationships between chewing behavior, digestibility and digesta kinetics parameters in steers fed restricted and ad libitum levels of oat hay. Four male Herefords with an average initial weight of 136 kg were used in an experiment conducted as a Latin square with 4 treatments and 4 periods. Animals were fed 4 levels of oats hay DM (*Avena strigosa* L.) namely: 1.5, 2.0, 2.5% BW/day and ad libitum representing the treatments T1, T2, T3 and T4, respectively. Chewing behavior, digestibility, and digesta kinetics measurements were recorded. Most of the measured parameters were better related to OM intake scaled by metabolic weight. Rumination and eating chewing rate (chews/min/g OM/kg<sup>0.75</sup>) decreased with increased OM intake whereas total chewing and total time spent on each chewing activity increased. Calculated total energy expended by chewing activity was 4.2, 4.4, 5.2 and 5.3%, of ME intake for T1, T2, T3 and T4 respectively. Digestibility of OM, DM, ADF, NDF, hemicellulose and



cellulose decreased with increased OM intake. Retention time (h) was strongly related to OM intake ( $\text{g/kg}^{0.75}/\text{day}$ ) ( $r = -0.85$ ), OM digestibility ( $r = 0.84$ ) and with ruminating ( $r = 0.81$ ) and eating chewing rate ( $r = 0.80$ ) highlighting the relationship between chewing behavior and the digestive process. Fractional outflow rate from the reticulo-rumen and that from the cecum-colon were positively related to total chews, indicating that decrease in particle size facilitates particle flow through the digestive tract. In conclusion, the results of this study show that animals fed a restricted diet altered their chewing behavior when eating and ruminating by increasing chewing rate (chews/min/g OM/BW<sup>0.75</sup>), which was also related to retention time and digestibility.

**Key Words:** chewing behavior, digestibility, digesta kinetics

**T357 Effect of different feeding regimens on growth performance and health of Sahiwal calves during pre-weaning period.** S. A. Bhatti<sup>\*1</sup>, M. F. Ahmed<sup>1</sup>, D. McGill<sup>2</sup>, M. Sarwar<sup>1</sup>, M. Afzal<sup>3</sup>, E. Ullah<sup>1</sup>, M. A. Khan<sup>4</sup>, M. S. Khan<sup>1</sup>, R. Bush<sup>5</sup>, and H. M. Warriach<sup>2</sup>, <sup>1</sup>University of Agriculture, Faisalabad, Pakistan, <sup>2</sup>EH Graham Centre (NSW Industry and Investment and Charles Sturt University), Wagga Wagga, Australia, <sup>3</sup>Pakistan Agricultural Research Council, Islamabad, Pakistan, <sup>4</sup>Livestock Production Research Institute, Bahadurnagar, Okara, Pakistan, <sup>5</sup>University of Sydney, Camden, Australia.

The objective of the study was to examine the growth potential of Sahiwal calves using recommended feeding practices (milk/milk replacer with concentrates and forage) in a clean environment. For this purpose, Sahiwal calves ( $n = 48$ ; 24 of each sex  $3 \pm 2$  d of age born in January/February 2009) were maintained in raised individual pens until weaning at d 84. Four groups each of 12 animals (6 of each sex) were offered liquid feed as either whole cow's milk or a commercial milk replacer (MR; reconstituted to specification; Sprayfo) to 10% of their body weight (traditional recommendation in Pakistan) from d  $3 \pm 2$  and solid feed as either a starter ration (SR; prepared at the University CP = 20%, TDN = 72%) plus Berseem hay (H; Egyptian Clover; CP = 21% TDN = 63%) or H only ad libitum from d 7. The milk or MR was withdrawn gradually from d 56 until weaned completely by d 84 but not the solid feed. The data were analyzed using repeated measure analysis by MIXED procedures of SAS. Calves offered milk grew faster than those offered MR ( $357 \pm 8$  vs.  $162 \pm 8$ ;  $P < 0.05$ ) and displayed higher weaning weights ( $51.6 \pm 0.7$  vs.  $35.2 \pm 0.7$ ;  $P < 0.05$ ). Similarly calves offered SR plus H grew faster ( $311 \pm 8$  vs.  $208 \pm 8$  g/d;  $P < 0.05$ ) and developed higher weaning weights ( $48.7 \pm 0.7$  vs.  $38.1 \pm 0.7$  kg;  $P < 0.05$ ) than those fed H alone. Male calves offered milk plus SR and H showed the highest growth rate and weaning weights ( $459 \pm 16$  g/d and  $62.9 \pm 1.4$  kg, respectively). The lowest growth rate and weaning weights were observed in female calves given MR and H only ( $108 \pm 16$  g/d and  $28.6 \pm 1.4$  kg, respectively). Calves offered the MR showed a greater incidence of calf scours than those offered the milk (88 vs. 42%, respectively). The feeding of whole milk in combination with starter ration and hay resulted in superior growth rates, higher weaning weights, and healthier calves than the other feeding regimens.

**Key Words:** calf nutrition, milk replacer

**T358 The effect of feeding different dilution levels of milk replacer to calves once or twice daily, with or without yeast culture.** M. F. Ortega<sup>\*</sup>, H. M. Rodriguez, and M. Vélez, Zamorano University, El Zamorano, Honduras.

Conventional feeding in the tropics for calves (2L of milk/milk replacer twice daily) was compared with a lower intake (3L once daily). Effects of live yeast culture (YC; YEA SACC 1026, Alltech, Inc.) addition were

investigated when added to these feeding strategies. A study was conducted using 40 male and female newborn calves assigned randomly to a  $2 \times 2$  factorial design to determine the effects on growth in terms of average daily gain (ADG), and initial/final body weight (BW). The treatments consisted of 2 levels of milk replacer: 3 L once a day (3L) or 4 L split in 2 feedings daily (4L). The amount of milk replacer (20% CP and 15% Fat) as such was similar (450 g/d), but diluted in the 3L or 4L treatment with (Y) or without (NY) YC addition. Calves were weaned at 60 d. BW was measured every 30 d until they were 120 d. The statistical analysis of this experiment was performed using the MIXED procedure of SAS. 3L or 4L calves had similar initial body weight ( $37.37$  and  $37.42 \pm 1.37$  kg, respectively;  $P = 0.98$ ), but calves assigned to the Y treatment were significant smaller than NY ( $34.03$  and  $40.76 \pm 1.37$  kg, respectively;  $P < 0.01$ ). Final weights of animals at 120 d followed the same pattern as initial weight. ADG at 60 d of 3L was similar to 4L calves ( $0.37$  and  $0.39 \pm 0.03$  kg/d, respectively,  $P = 0.50$ ), but Y calves had a lower ADG than NY ( $0.31$  vs.  $0.44 \pm 0.03$  kg/d;  $P = 0.006$ ). There were no effects of milk replacer or YC addition on ADG at 120 d ( $0.44 \pm 0.02$  kg/d). These results suggests that there is no difference between the diluted levels of milk replacer (3L or 4L) on ADG when grain was offered ad libitum, and that YC-calves had a lower ADG at 60 d but similar ADG after 120 d.

**Key Words:** calves, milk replacer, yeast culture, average daily gain

**T359 Utilization of yeast (*Saccharomyces cerevisiae*) in dairy calf diets.** J. A. De Freitas<sup>\*1</sup>, M. S. Schoten<sup>1</sup>, D. R. Fronchetti<sup>1</sup>, A. F. Garcez Neto<sup>1</sup>, and J. C. De Souza<sup>2</sup>, <sup>1</sup>University Federal of Parana, Palotina, Parana, Brazil, <sup>2</sup>University Federal of South Mato Grosso, Aquidauana, Mato Grosso do Sul, Brazil.

There are few farms that give priority to calf rearing. Most of farms justify that the economic impact of investments in calf rearing does not provide significant profits. However, feed management practices that can improve animal performance, prevent enteric diseases (diarrhea) and reduce production costs are of great interest. Among the practices used in food nutrition, the inclusion of some substances (additives) in the diet may be responsible for improving digestibility, nutrient absorption and thus in the feed conversion. The aim of this study was to assess the influence of 3 levels of yeast (*Saccharomyces cerevisiae*) in the Holstein calves diet on the weaning weight (W60), weight gain from birth to weaning (WG), average daily gain from 0 to 60 d (ADG), concentrate feed conversion (CFC) and diarrhea incidence (ID). Twenty-one Holstein calves were randomly assigned to 3 treatments consisting of different levels of yeast in the diet (0, 5 and 10 g/animal/day). Immediately after birth, animals were separated from their mothers and transferred to individual pens where they received 5 L of colostrum for 3 d. After that period, the calves received 8 L of colostrum/day divided in 3 meals. The yeast was mixed with the milk of the first meal. From the 2nd week animals had ad libitum access to concentrate feed containing 18% crude protein and 75% TDN. The amount of concentrate ingested was controlled daily. The animals were weighed and had their height measured at birth and every 15 d (0, 15, 30, 45 and 60 d). The data were analyzed by PROC REG of SAS. It was found a quadratic effect of the treatments for WG (kg), ADG (kg) and CFC variables. The equations and their respective coefficient of determination were:  $WG = 394167 + 3.8178x - 0.3802x^2$  ( $r^2 = 0.25$ ),  $ADG = 0.6567 + 0.0642x - 0.006387x^2$  ( $r^2 = 0.55$ ) and  $CFC = 0.4317 + 0.0482x + 0.0046x^2$  ( $r^2 = 0.55$ ). The addition of yeast culture in the calf diet improved feed conversion into increased growth.

**Key Words:** additives, ruminant nutrition, nutrition efficiency

**T360 The effects of feeding fermented soybean meal in calf starter on growth and performance of dairy calves.** T. L. Wolfswinkel<sup>\*1</sup>, H. D. Tyler<sup>1</sup>, J. E. Cunnick<sup>1</sup>, T. Waugh<sup>2</sup>, J. Sewell<sup>2</sup>, and A. Chestnut<sup>3</sup>, <sup>1</sup>*Iowa State University, Ames*, <sup>2</sup>*Nutra-Flo Protein and Biotech Products, Sioux City, IA*, <sup>3</sup>*Vigortone Ag Products, Brookville, OH*.

The use of soybean meal in animal diets is primarily limited to adult animals due to the inefficient digestibility of soy proteins by young animals and the susceptibility of young animals to antinutritional compounds in soybeans that are either not properly processed or undercooked. The objective of this study was to evaluate the suitability of fermented soybean meal for use in dairy calf starter diets in place of soybean meal. The experiment was conducted using 66 dairy bull calves that were randomly assigned to either the control diet, containing soybean meal (SBM) as the primary source of protein in the starter diet, or the treatment diet, containing fermented soybean meal (FSBM) in place of

soybean meal as the primary source of protein in the starter diet. Measured parameters included weekly weight gains, total weight gained, attitude, appetite, fecal scores, and immunological parameters that included mitogen proliferation, CD4, CD8, CD45RO, and B-cell counts which were measured by flow cytometry. None of the measured growth and health parameters were significantly different between the calves on the control and treatment diets. Weaning age was older for calves on the fermented soybean meal in comparison to the soybean meal based starter diet ( $P = 0.0422$ ). Immunological data showed no differences in the development and responsiveness of the immune system between groups of calves receiving different treatments. This data suggests that growth and performance of calves fed fermented soybean meal based starter diets are similar to those fed soybean meal based diets.

**Key Words:** fermented soybean meal, calves, immune system development