

Ruminant Nutrition: Young Stock

T352 Effects of limiting concentrate during growing period on performance and plasma variables, and gene expression of hepatic gluconeogenic enzymes in Holstein calves. J. D. Lohakare,* N. K. Singh, J. Ghassimi Nejad, K. I. Sung, and S. L. Ingale, *College of Animal Life Sciences, Kangwon National University, Chuncheon, Kangwon Province, South Korea.*

This study elucidated the effects of limited concentrate feeding on growth, plasma profile, and gene expression of gluconeogenic enzymes in the liver of dairy calves. The study utilized 12 Holstein male dairy calves (100 d of age) divided into 2 groups of 6 calves each for 155 d. Control group calves received 1.8 kg/(calf × day) of concentrate, whereas calves in the restricted group only received 1 kg/(calf × day). Good quality forage (Timothy hay) was available for ad libitum consumption to both groups. Body weights (BW) were recorded at start and at fortnightly intervals. Blood samples were collected at start and approximately 50 d interval. On d 100 and 155, liver biopsies were collected from all animals in each group. The BW was not different between the groups at the end of the study, however, at 6, 7, 8 and 9 fortnights higher ($P < 0.05$) BW were recorded in the control group than the restricted. Total BW gain in the control group was 114 kg as opposed to 98.2 kg in restricted group that led to average BW gain of 736 g/day and 634 g/day in respective groups, and the differences were significant ($P = 0.051$). As planned, the calves in the control group had higher concentrate and lower forage intake than the restricted group. The plasma variables (glucose, total protein, albumin, urea nitrogen, alanine aminotransferase (EC: 2.6.1.2) and amylase (EC: 3.2.1.1)) were within the normal range in both groups, but aspartate aminotransferase (EC: 2.6.1.1) was higher ($P < 0.05$) in control than restricted group and plasma triglycerides tended to be higher ($P = 0.069$) in restricted group than control. The mRNA expressions for the gluconeogenic enzymes, cytosolic phosphoenolpyruvate carboxykinase (EC 4.1.1.32) and pyruvate carboxylase (EC 6.4.1.1) measured by quantitative real-time PCR in liver biopsies showed no differences between groups. Overall, restricting concentrate moderately reduced the growth intensity without affecting the normal plasma indices and gene expression indicating that both concentrate feeding schemes can be successfully applied.

Key Words: calf, concentrate, gluconeogenic enzymes

T353 Plane of nutrition during the pre- and post-weaned periods influences the performance and innate immune activity of Jersey calves. D. L. Hanson*¹, C. J. Cobb¹, M. D. Sellers¹, T. J. Earleywine², and M. A. Ballou¹, ¹*Department of Animal and Food Sciences, Texas Tech University, Lubbock,* ²*Land O'Lakes, Animal Milk Products Co., Shoreview, MN.*

Objective was to determine the influence of plane of nutrition during the pre- and post-weaned periods on the performance and innate immune activity of Jersey calves. Forty six (3 ± 1 d old) calves were randomly assigned to 2 treatments. Treatments were a low (LP; $n=23$) and high plane of nutrition (HP; $n=23$). Calves in LP treatment were fed 409 g/d DM of a 20/20 milk replacer; whereas calves in HP treatment were fed 610 and 735 g/d DM of a 28/25 during the 1st wk and wk 2-6, respectively. Weaning was initiated during the 7th wk by removing the PM feeding and calves were completely weaned when they were consuming 800 g of calf starter after d 49. Calves were fed their respective calf starter until the end of the study. Peripheral blood samples were collected on d 0, 7, 21, 28, 42 and 77 for biochemical analyses. Blood samples collected on d 7, 21, 42, and 77 were analyzed for ex vivo innate immune responses. As

expected, metabolizable energy intake, crude protein intake, and average daily gain were greater ($P < 0.001$) during the pre-weaning period for HP calves. There were treatment × time interactions ($P < 0.001$) on plasma concentrations of glucose and urea nitrogen. Glucose concentrations were greater ($P < 0.01$) on d 21, 28, 42 and tended to be greater ($P < 0.10$) on d 77 among HP calves. Urea nitrogen concentrations tended to be greater ($P < 0.10$) on d 7 among HP calves, but were less ($P < 0.01$) than LP calves on d 42 and 77. Secretion of tumor necrosis factor- α from diluted whole blood when co-cultured with lipopolysaccharide was greater ($P < 0.05$) among HP calves on d 7. In contrast, neutrophil expression of L-selectin was greater ($P < 0.05$) among LP calves on d 7, 21, and 42. No treatment or treatment × time differences ($P = 0.798$) were observed for neutrophil oxidative burst capacities during the study. Lastly, plasma haptoglobin concentrations were decreased ($P 0.05$) among HP calves on d 21. These data suggest that HP may prime the pro-inflammatory response of calves on d 7, but that a LP increases the basal expression of L-selectin on circulating neutrophils during the entire preweaned period.

Key Words: calf, immune, plane of nutrition

T354 Influence of tannins-extract supplementation on plasma urea nitrogen concentration of bull-calves grazing Bermuda grass.

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Forty *Bos indicus* × *Bos taurus* bull-calves $176.43 \pm$ SD 17.74 kg were used to determine the influence of tannins-extract supplementation on plasma urea nitrogen concentration of bull-calves grazing Bermudagrass. The experiment was performed from May 6 to June 3 of 2011 in the coast-plains of Sinaloa, localized in the Northwest of Mexico. Bull-calves were individually ear-tagged, weighed and randomly assigned to one of the next treatments: 1) Grazing in Bermuda paddock and receiving 1.5 kg/d of a protein supplement (Control); or 2) Similar to Control plus tannins-extract supplementation (TE). In groups of 20 bull-calves were placed in 2 3-ha paddocks of irrigated prairies of Bermudagrass (*Cynodon dactylon* L.), exclusively fertilized with feedlot cattle-manure. The protein supplement was formulated to contain 21% CP and 1.99 Mcal of NEm by kg of DM, and its composition was as follows: 70.5% Corn dried distillers grains with solubles, 10% ground corn, 2.5% sugar cane molasses, and 17% of sea salt. Protein-supplement was delivered daily in amount equivalent to 1.5 kg/animal. Bull-calves in TE treatment receiving daily 33 g of TMP-Protein Enhancer (Técnica Mineral Pecuaria, México) a premix that contains 56% of condensed and soluble tannins-blend. Tannins extract was incorporated in the protein supplement. In d 1 and 28, blood samples were taken from jugular vein for plasma urea nitrogen (PUN) determination. At the beginning of the experiment in d 1, plasma urea nitrogen concentration was similar ($P = 0.10$) between treatments, with mean values of 16.40 and 17.95 mg/dL for Control and TE treatments, respectively. In d 28, TE-supplementation decreased ($P < 0.01$) 21.6% PUN concentration, with mean values of 15.75 and 12.35 mg/dL for Control and TE treatments, respectively. The results suggest that tannins-extract supplementation is able to decrease plasma urea nitrogen concentration of bull-calves grazing tropical grasses as Bermudagrass.

Key Words: tannins, plasma urea nitrogen, bull-calves

T355 The influence of grassland management and housing on voluntary dry matter intake in heifers. O. Latal^{*1}, J. Pozdisek², and J. Bezdicek¹, ¹*Agrovyzkum Rapotin Ltd., Vikyrovce, Czech Republic*, ²*Research Institute for Cattle Breeding Ltd., Vikyrovce, Czech Republic*.

The aim of this study was to determine the voluntary dry matter intake (VDMI) of silage from grasslands managed in 3 ways. Fourteen experiments were conducted in 2010 on 2 groups of heifers, 6 per group (Czech Fleckvieh, 300 ± 15 kg LW) and housed in 2 ways: loose-box housing (4 automatic roughage intake control troughs) and tie-stall housing (manual feeding). Each experiment was divided into a habituation period (14 d) and a testing period (10 d). Grasslands were managed as follows: A [Medium Intensive Utilization] - 3 cuts per year, N₉₀P₃₀K₆₀ pure nutrients in kg per year and ha; B [Low Intensive Utilization] - 2 cuts per year, N₉₀P₃₀K₆₀; and C [Extensive (control) Utilization] - 2 cuts per year, nil-fertilization. The grass silage was made by cutting grass and leaving it to dry naturally in the field. After wilting, (dry matter 38%) the mowed fodder was compressed into round bales. The data were analyzed using GLM with the software R version 2.9.1. The results of the VDMI for each group of heifers was calculated in grams (dry matter) per metabolic body unit (W^{0.75}); next displayed as (g/MBU). Value of VDMI ($P < 0.01$) was higher in A (88.41 g/MBU, SE = 0.57) and B (72.14 g/MBU, SE = 0.60) than in C (68.34 g/MBU, SE = 0.63). Value of VDMI ($P < 0.05$) was higher too for the loose-box housing system (80.33 g/MBU, SE = 0.61) than the tie-stall housing system (74.42 g/MBU, SE = 0.65). On average from grasslands managed in 3 ways (from A to C), the NDF content rose from 486.8 to 571.1 g/kg dry matter (DM) and the net energy for lactation (NEL) decreased from 5.4 to 4.9 MJ/kg DM. There was a significant negative correlation between VDMI and the NDF ($r = -0.82$; $P < 0.05$), as well as a positive correlation between the VDMI and NEL ($r = 0.79$; $P < 0.05$). On the basis of the results, we can conclude that the value of the VDMI and nutrient intake was influenced by the grassland management (the higher the intensity of utilization, the higher the VDMI and nutrient intake) and housing system (greater VDMI was found for the loose-box housing).

Key Words: voluntary dry matter intake, grassland

T356 Effect of time of access to temperate forage on intake and digestibility of organic matter and fiber fractions in heifers. A. Félix¹, N. Hernández¹, P. Restuccia¹, S. Ruiz¹, M. Aguerre¹, A. Pérez-Ruchel², J. L. Repetto¹, and C. Cajarville^{*2}, ¹*Departamento de Bovinos, Facultad de Veterinaria, UdelaR, Montevideo, Uruguay*, ²*Departamento de Nutrición Animal, Facultad de Veterinaria, UdelaR, Montevideo, Uruguay*.

Twenty-four Hereford × Angus heifers (BW = 153 ± 18 kg) were used in a randomized complete block design to determine the effect of time access to forage (*Lolium multiflorum*, *Trifolium repens*; 19.1% CP, 48.2% NDF, 23.2% ADF DM basis) on OM, NDF and ADF intake (OMI, NDFI and ADFI, respectively) and apparent digestibility of OM, NDF and ADF (D_{OM}, D_{NDF} and D_{ADF} respectively). Pasture was daily cut and offered ad libitum as sole feed during 4, 6, 8 or 24 h from 0800 h (h0), for the treatments T4, T6, T8 and T24, respectively. Daily OMI, NDFI and ADFI were measured for 10 d as the difference between offer and refusal and D_{OM}, D_{NDF} and D_{ADF} were studied for 5 consecutive days determining the daily total amount of food consumed and feces produced. All data were compared between treatments using a mixed linear model. Mean OMI were 40.6, 54.9, 58.8, 70.3 g OM/kg BW^{0.75} (SEM = 3.8), mean NDFI were 21.3, 29.1, 31.1 and 37.3 g NDF/kg BW^{0.75} (SEM = 2.1) and mean ADFI were 10.6, 14.3, 15.3, 18.5 g ADF/kg BW^{0.75} (SEM = 1.0) for treatments T4, T6, T8 and T24, respectively.

Organic matter intake, NDFI and ADFI were lower ($P < 0.001$) in the more restricted animals (T4 and T6) than in T24, but no differences were detected between treatments T6 and T8, or T8 and T24. Apparent digestibility of OM, D_{NDF} and D_{ADF} were high for all treatments (mean values: 81.7% (SEM = 1.4), 69.7% (SEM = 3.4) and 55.6% (SEM = 5.5), respectively) with no differences among them ($P > 0.10$), despite the large differences observed in intake. We conclude that restricting time of access to a high quality pasture below 8 h reduced OMI, NDFI and ADFI, but it did not affect its digestibility.

Key Words: feed restriction, pasture

T357 Assessment of bone metabolism in pregnant heifers with high and low residual feed intake. R. Dias¹, J. Kim^{*1}, S. Lopez², Y. Montanholi¹, B. Smith¹, S. Miller¹, and J. France¹, ¹*University of Guelph, Guelph, Ontario, Canada*, ²*Universidad de León, Leon, Leon, Spain*.

It is known that ruminants with lower residual feed intakes (RFI) use nutrients more efficiently than animals with higher RFI. However, the biological reasons and metabolic consequences underlying the variation in RFI between animals are not clear. There is also no information on whether RFI is related to differences in bone metabolism. Within this context 26 pregnant heifers (13 low RFI + 13 high RFI) in their first trimester of gestation were used for a bone metabolism study. Their blood was sampled once in the morning before feeding through jugular catheterization for analysis of osteocalcin and crosslaps in serum. These compounds are biochemical markers of bone formation and resorption respectively considered important clinical tools for assessment and monitoring of bone metabolism. Both markers were determined quantitatively using an immunoassay kit specifically for bovines. The results showed a lack of difference between animals with high and low RFI in the concentration of osteocalcin in serum with average concentration of 27 ± 10.9 ng/mL similar for both groups ($P > 0.05$), indicating that the efficiency of feed utilization by pregnant heifers does not affect their bone formation. Likewise the concentrations of bovine crosslaps were similar between the 2 groups of animals ($P > 0.05$), though the more efficient animals had a mean concentration of 16 ± 10.3 ng/mL and the group of animals with higher RFI gave a mean concentration of 8 ± 7.7 ng/mL. These findings suggest bone resorption is not affected by feed efficiency in pregnant heifers. Thus, this research provides an indication that bone metabolism is similar for pregnant heifers with lower and higher RFI. However more research is needed to provide further information.

Key Words: bone marker, feed efficiency, pregnant heifer

T358 Dried citrus pulp alters feedlot performance of crossbred heifers during the receiving period. J. T. Cribbs^{*1}, T. R. Young¹, M. A. Jennings¹, N. C. Burdick², J. A. Carroll², T. R. Callaway³, T. B. Schmidt⁴, B. J. Johnson¹, and R. J. Rathmann¹, ¹*Texas Tech University, Lubbock*, ²*USDA-ARS, Livestock Issues Research Unit, Lubbock, TX*, ³*USDA-ARS, Food and Feed Safety Research Unit, College Station, TX*, ⁴*Mississippi State University, Department of Animal and Dairy Science, Starkville*.

A study was designed to determine the effects of feeding dried citrus pulp pellets (DCP) on feedlot performance of newly received English × Continental heifers. Heifers (n = 180) were sourced in 2 loads (188.7 ± 18.0 kg and 225.2 ± 22.2 kg, respectively) from commercial auction barns and placed on trial at the Texas Tech University Beef Center in New Deal, Texas. A completely randomized block design was used by blocking by

BW nested within arrival load with 3 treatment diets being applied (36 pens; 5 heifers/pen; 12 blocks; 3 pens/block; 12 pens/treatment). Treatment diets were formulated to contain: 1) 0%; 2) 10%; or 3) 20% DCP on a DM basis. Diets containing DCP were formulated to be exchanged with steam flaked corn on a 1:1 basis. Cattle were fed a 63, 73, and 83% concentrate diet from d 0 to 28, d 28 to 42, and d 42 to 56, respectively. From d 0 to 28, there was a linear decrease in DMI ($P < 0.0001$) which resulted in a linear decrease in ADG ($P < 0.0001$) and G:F ($P < 0.01$) as the proportion of DCP in the diet was increased. From d 28 to d 42, DMI decreased linearly ($P = 0.02$) as the proportion of DCP in the diet increased; however, no difference in ADG was observed and G:F increased linearly ($P < 0.01$) in favor of treatments with a higher proportion of DCP. From d 42 to d 56, DMI did not differ across treatments, but ADG ($P = 0.02$) and G:F ($P = 0.04$) decreased linearly as the proportion of DCP in the diet increased. Over the entire 56 d trial period, as the proportion of DCP in the diet increased DMI decreased ($P = 0.02$; 6.70, 6.13, and 5.96 kg, for 0, 10, and 20% DCP, respectively), ADG decreased ($P < 0.0001$; 1.88, 1.27, and 1.00, respectively), and G:F decreased ($P = 0.02$; 0.225, 0.210, 0.91, respectively). Collectively, it appears that regardless of the level of roughage in the diet, the inclusion of DCP pellets at levels of 10% or greater lowers DMI such that feedlot performance suffers. Future studies will need to evaluate inclusion levels of DCP less than 10% or evaluate alternative processing strategies of DCP to offset the negative effects of DCP on intake in diets of newly received calves.

Key Words: newly received cattle, feedlot performance, citrus pulp

T359 Effect of time of access to temperate pasture on nitrogen utilization, digestibility of nitrogen and microbial protein synthesis in heifers. N. Hernández¹, A. Félix¹, A. Pérez Ruchel², M. Aguerre¹, C. Cajarville², and J. L. Repetto*¹, ¹Departamento de Bovinos, Facultad de Veterinaria, UdelaR, Montevideo, Uruguay, ²Departamento de Nutrición, Facultad de Veterinaria, UdelaR, Montevideo, Uruguay.

The aim of this study was to evaluate if the time of access to forage (*Lolium multiflorum*, *Trifolium repens*; 19% CP, 48% NDF, DM basis) affects the nitrogen (N) utilization, apparent digestibility of N (D_N) and the microbial protein synthesis (MPS) in heifers consuming temperate pastures. Twenty-four cannulated heifers (153.1 ± 18.1 kg BW) in a randomized complete block design were housed in individual cages and assigned to one of 4 treatments: T4, T6, T8 and T24 according to the time of access to fresh forage: 4, 6 8 or 24h/d, respectively. Pasture was daily cut and offered ad libitum as sole feed for all the treatments. Daily intake of N was measured for 10 d and D_N was determined for 5 consecutive days. Urine N was studied based on the daily total urine collected during 5 d. The retained N was calculated as: N intake (g/d) - (N removed in feces (g/d) + N eliminated in urine (g/d)). MPS was estimated by the determination of urinary purine derivatives excretion using the HPLC technique. All data were analyzed using a linear mixed model. The D_N was high for all treatments (mean value: 80.9%, SEM = 1.5) with no differences among them ($P > 0.10$), despite the large differences that were observed in intake. Mean N intake were 1.4, 1.9, 2.0 and 2.4 gN/kg BW^{0.75} (SEM = 0.1, $P < 0.001$) for T4, T6, T8 and T24, respectively. The fecal excretion of N was higher for the T24 group than for the T4 group ($P < 0.001$). Similarly, there was a trend for the urinary N removal to increased for animals that were fed all day regarding to T4 group ($P = 0.07$). Animals in T4 had lower N retention than animals in T8 and T24 with mean values of 6.0, 24.3 and 30.1 gN/d (SEM = 3.5, $P < 0.001$). We observed a strong trend toward greater MPS for the unrestricted group (T24) than for the T4 group (46.7 and 20.0 gNM/d respectively; SEM = 7.2, $P = 0.057$). However, there was no difference between treatments ($P > 0.10$) in the efficiency of synthesis expressed

as gMN/kgDOMI. We conclude that restricting time of access to forage reduced N intake that could have affect microbial protein synthesis.

Key Words: heifers, microbial protein, nitrogen utilization

T360 Comparison of pH, volatile fatty acids, and microbial quantification on rumen samples from young calves obtained via cannula or stomach tube. M. Terré*¹, Ll. Castells¹, and A. Bach^{2,1}, ¹Institut de Recerca i Tecnologia Agroalimentàries, Caldes de Montbui, Spain, ²Institució Catalana de Recerca i Estudis Avançats, Barcelona, Spain.

The objective of this study was to compare rumen samples from young dairy calves obtained via a stomach tube (ST) or a ruminal cannula (RC). Five Holstein male calves (46 ± 4.0 kg of BW and 11 ± 4.9 d of age) were ruminally cannulated at 15 d of age. Calves received 4 L/d of a commercial milk replacer (25% CP and 19.2% fat) at 12.5% DM, and starter and chopped oat hay ad libitum throughout the study (56 d). A total of 29-paired rumen samples, obtained at different ages by each extraction method, were used to determine pH, VFA concentration, and quantify *Fibrobacter succinogenes* by qPCR. A paired *t*-test was used to determine whether the evaluated parameters differed between the rumen samples obtained from the different methods. There was a difference ($P < 0.05$) of 0.30 pH units between ST and RC samples, being greater in ST than in RC samples. Furthermore, the total VFA concentration was greater ($P < 0.001$) in RC than in ST samples. However, when analyzing the proportion of each VFA, the method of sampling only affected ($P < 0.05$) the relative proportion of butyric, isovaleric, and valeric acid. Probably, saliva contamination diluted ST samples lowering the VFA concentrations and causing small changes in VFA profile. On the other hand, the quantification of *Fibrobacter succinogenes* by qPCR was not affected ($P = 0.43$) by the extraction method. In conclusion, when comparing rumen parameters from different studies, it is preferred to use VFA profiles rather than total VFA concentrations, as the latter is more affected by the method of collection. Furthermore, while pH comparisons across studies should be avoided when samples are not obtained by the same sampling method, the comparison of specific rumen bacteria can be acceptable.

Key Words: rumen cannula, rumen samples, stomach tube

T361 Effects of limiting concentrate during growing period on performance and plasma variables, and gene expression of hepatic gluconeogenic enzymes and visfatin in Korean native beef calves. J. D. Lohakare*¹, S. S. Chang², N. K. Singh¹, E. G. Kwon², J. Ghassemi Nejad¹, K. I. Sung¹, and S. K. Hong², ¹College of Animal Life Sciences, Kangwon National University, Chuncheon, South Korea, ²Hanwoo Experimental Station, National Institute of Animal Science, RDA, Pyeongchang, South Korea.

This study elucidated the effects of limited concentrate feeding on growth, plasma profile, and gene expression of gluconeogenic enzymes and visfatin in the liver of Hanwoo beef calves. The study utilized 20 Korean native beef calves (Hanwoo; 60–70 d of age) divided into 2 groups of 10 calves each for 158 d. Control group calves received the amount of concentrate as per the established Korean feeding standards for Hanwoo, whereas calves in the restricted group only received half the amount of concentrate as per standard requirements. Good quality forage (Timothy hay) was available for ad libitum consumption to both groups. Since calves were with their dam until 4 mo of age in breeding pens before weaning, the intake of milk before weaning was not recorded, however, the concentrate and forage intakes were recorded

daily. Body weights (BW) were recorded at start and on 10–15 d interval. Blood samples were collected at start and at 50 d interval. On the final day of the experiment, liver biopsies were collected from all animals in each group. The BW was not different between the groups at all times, but tended to be higher ($P = 0.061$) only at final BW in control than restricted group. Total BW gain in the control group was 116.2 kg as opposed to 84.1 kg in restricted group that led to average BW gain of 736 g/day and 0.532 g/day in respective groups, and the differences were significant ($P < 0.01$). As planned, the calves in the control group had higher concentrate and lower forage intake than the restricted group. The plasma variables (glucose, total protein, albumin, urea, triglycerides, aspartate aminotransferase (EC: 2.6.1.1), alanine aminotransferase EC: 2.6.1.2) and amylase (EC: 3.2.1.1) were within the normal range in both groups, but plasma total protein, and urea were higher ($P < 0.05$) in control than restricted group and aspartate aminotransferase, alanine aminotransferase levels were lower ($P < 0.05$) in control than restricted group showing the effects of diet. The mRNA expressions for the gluconeogenic enzymes such as cytosolic phosphoenol pyruvate carboxykinase (EC 4.1.1.32) and pyruvate carboxylase (EC 6.4.1.1), and visfatin measured by quantitative real-time PCR in liver biopsies showed higher expression ($P < 0.05$) in restricted group than control. Overall, restricting concentrate severely reduced the growth intensity and gene expression in liver and few plasma indices indicating that restricting concentrate in the feeding schemes during early growth for beef calves is not advocated.

Key Words: Hanwoo calves, concentrate, gluconeogenic enzymes

T362 How the provision of forage in pre-weaned calves affects performance and digestibility after weaning. Ll. Castells^{*1}, A. Bach^{1,2}, C. Montoro¹, E. M. Rodríguez¹, P. Ureña¹, and M. Terré¹, ¹Department of Ruminant Production, IRTA, Caldes de Montbui, Spain, ²ICREA, Barcelona, Spain.

The objective of this study was to evaluate performance and diet digestibility after weaning in young Holstein calves fed non-forage and

forage-supplemented diets during the pre-weaning phase. Sixty female Holstein calves (BW = 39.5 ± 3.76 kg) were randomly assigned to one of the 2 dietary treatments according to age and BW. Calves were individually housed and bedded with wood shavings. Dietary treatments consisted on feeding a pelleted starter (19% CP, 19% NDF) without any forage supplementation during the pre-weaning phase, and oats hay (68% NDF) supplementation post-weaning (CTR) or the same starter and forage fed during the pre and post-weaning phase (OAT). All calves were offered 3 L of milk replacer (MR) at 12% DM fed twice daily until 28 d of age, from 29 to 44 d of age calves received 1.5 L of MR at 12% DM fed twice daily, and from 45 to 51 d of age calves received 1.5 L of MR at 12% DM. Animals were weaned at 52 d of age. Intakes of starter and forage were recorded daily and BW weekly. Two weeks after weaning, total tract apparent digestibility was determined in 6 calves per treatment. Data were analyzed with a mixed-effects model with repeated measures, except for digestibility values that had no repeated measures. Starter intake was greater ($P < 0.05$) in OAT compared with CTR animals (600 vs 503 ± 40.1 g/d, respectively) during the pre-weaning period. As a result, calves in OAT treatment grew faster ($P < 0.01$) than CTR animals (520 vs 419 ± 22.9 g/d, respectively) during the pre-weaning period. After weaning, OAT animals consumed more ($P < 0.01$) forage than CTR animals (146 vs 90 ± 11.7 g/d, respectively), but there were no differences between treatments in ADG and starter intake. Similarly, there were no differences in total tract apparent digestibility between treatments (78.3% DM digestibility, 43.0% NDF digestibility). Offering forage to young calves is necessary, and when offered early in life it allows improvements in growth before weaning.

Key Words: calves, forage, performance