

Ruminant Nutrition: Carbohydrates - Dairy

T190 Effects of beet pulp substituted for barley grain in fat cows ration at the late lactation. E. Mahjoubi*, H. Amanlou, D. Zahmatkesh, M. Ghilichkhan, and N. Aghaziaraty, *Zanjan University, Zanjan, Iran.*

In order to examine the effects of increasing concentrations of beet pulp (lipogenic nutrient) substituted for barley grain (glycogenic nutrient) on productive performance, BCS loss, and blood metabolites, 18 Holstein cows were used. The cows were 171 ± 16 d in pregnancy and 289 ± 35 d in milk at the beginning of the experiment. The cows's BCS were 4.12 ± 0.35 at the beginning of the trial. The cows were assigned randomly to three dietary treatments containing 1) 23.47% barley (0% beet pulp), 2) 14.87% barley (8.6% beet pulp), or 3) 6.27% barley (17.2% beet pulp). Substituting beet pulp for barley grain didn't affect FCM 3.5%, milk protein, lactose, total solid, and SNF percentage, but milk fat percentage (4.37, 4.91, and 5.18, $P < 0.003$) and milk energy (0.76, 0.82, and 0.84 Mcal/kg, $P < 0.02$) increased as beet pulp were replaced barley, respectively. A tendency was detected for a more negative BCS change (0.13, -0.09, and -0.12, $P < 0.13$) and back fat thickness (2.5, -0.4, and -1.6 mm, $P < 0.13$) with added beet pulp. Plasma glucose (65.83, 58, and 57.16 mg/dl, $P < 0.01$) and cholesterol (157.33, 122.4, and 120.8 mg/dl, $P < 0.03$) decreased as beet pulp were substituted for barley grain, respectively. No difference was found in the plasma content of insulin and NEFA between treatments. In summary, these results suggest that with inclusion beet pulp in fat cows diet during late lactation may be slightly reduce BCS safely and inhibit of concomitant low production with diet diluting.

Key Words: Fat Cow, Beet Pulp, Barley

T191 Intake and ponderal development of dairy heifers fed sugar cane and different protein levels diets. M. F. S. Queiroz^{1,2}, T. T. Berchielli^{1,2}, R. D. Signoretti³, A. F. Ribeiro^{1,2}, and P. H. M. Dian^{1,2}, ¹*Faculdade de Ciências Agrárias e Veterinárias-UNESP, Jaboticabal, São Paulo, Brasil,* ²*Fundação de Amparo à Pesquisa do Estado de São Paulo-FAPESP, São Paulo, Brasil,* ³*Agência Paulista de Tecnologia dos Agronegócios, Colina, São Paulo, Brasil.*

The objective of this work was to evaluate the intake, performance and ponderal development of heifers fed sugar cane and four different protein levels diets. The sugar cane (IAC 862480) was evaluated during August to November (winter/spring) and the diets concentrate was compound by corn meal, soybean meal, urea, ammonia sulfate and mineral mix, in different proportions, to obtain the protein levels (10, 12.5, 15 and 17.5% of crude protein) in 70:30 relation forage and concentrate. Twenty-four Holstein × Zebu crossbred heifers were maintained in individual stalls and *ad libitum* fed twice on day (8 and 16h) during the adaptation and experimental period, 15 and 62 days, respectively. The animals were distributed in a block-randomized design, with four treatments and six replicates. The heifers were weighed and their thoracic perimeter, hip and croup height were determined at the beginning and at the end of the experimental period, at every 21 days. There was no difference ($P > 0.05$) between different protein levels for intake, daily weight gain and ponderal development of dairy heifers. However, although similar statistic results, the high protein level diet, 17.5% crude protein, promoted the best feed conversion (8,3).

Table 1. Average dry matter intake, daily weight gain and ponderal development of dairy heifers

	Diets protein levels (%)				CV(%)
	10	12.5	15	17.5	
Intake ¹	7.3	7.4	7.4	7.6	11
Intake ²	2.6	2.6	2.7	2.8	7
Daily WG (kg)	0.82	0.87	0.87	1.01	37
FC	10.7	12.3	13.2	8.3	54
Hip height*	120	120	121	120	3
Croup height*	123	124	125	124	2
Thoracic perimeter*	156	158	156	156	3

Means in the same row with different letters are different ($P < 0.05$); CV(%)=Coefficient of variation; *cm; ¹kgDM/day; ²%BW; FC=Feed conversion (DM intake/gain)

Key Words: Feedlot, Heifer Reraising, Weight Gain

T192 Effects of different ratios of nonfiber carbohydrate to ruminant degradable protein on the performance of Holstein cows in barley based diets. H. Rafiee¹, A. Afzalzadeh¹, A. Khadem¹, and A. Asadi², ¹*University of Tehran, Aboureihan Campus, Tehran, Iran,* ²*Isfahan University of Technology, Isfahan, Iran.*

Nine multiparous midlactation Holstein cows averaging 171 ± 17 days in milk and 24.1 ± 3.2 Kg of milk/d were assigned into a replicated 3×3 Latin square design to study the effects of altering nonfiber carbohydrate (NFC) to ruminant degradable protein (RDP) ratio on performance and nutrient digestibility. NFC:RDP ratios were 4.07, 3.71 and 3.34. Ratios were achieved through altering RDP content of diets while NFC was held constant at 40% DM. Urea was supplemented as a source of RDP to decrease the ratio. Crude protein (CP) contents were 14.3, 15.3 and 16.3% DM respectively. Each period lasted 21 days with last 7 days for milk and feces sampling. Results were analyzed by MIXED models with effect of cow(square) as a random and days of sampling in each period as repeated measures. Differences declared as significant where $P < 0.05$. Results showed that indicators of nitrogen metabolic efficiency were more affected than milk yield confirming that low producing cows are less likely to respond to altering NFC:RDP ratio. Hence, balancing rations to further improve the nitrogen utilization efficiency may be of higher priority value.

Table 1: Effect of NFC:RDP ratios on milk production and composition, nutrient intake and digestibility

Trait	NFC:RDP ratios				SEM	P<	Contrast	
	4.07	3.71	3.34				L	Q
DMI, Kg/d	21.8	21.3	21.0	0.59	0.002	0.07	0.74	
NI, g/d	423.2	466.3	489.4	16.17	0.003	0.01	0.62	
Milk, Kg/d	22.9	23.0	23.4	0.92	0.36	0.48	0.83	
Milk fat, %	3.31	3.44	3.36	0.12	0.66	0.67	0.69	
Milk protein, %	3.00	3.07	3.08	0.02	0.003	0.01	0.29	
MUN, mg/dl	11.20	12.88	13.90	1.18	0.04	0.07	0.42	

NI;Nitrogen intake, L;linear effect, Q;quadratic effect

Key Words: Nonfiber Carbohydrates, Rumen Degradable Protein

T193 An alternative low-starch compared with a traditional high-starch calf starter results in similar growth rate and rumen development at weaning. M. Vestergaard*, L. Puggaard, A. Kosiorowska, S. K. Jensen, N. B. Kristensen, and J. Sehested, *Faculty of Agricultural Sciences, University of Aarhus, Foulum, Denmark.*

The objective was to evaluate the consequences on growth performance and rumen development of using an alternative low-starch concentrate (ALT) compared with a traditional high-starch concentrate (TRA) fed at normal (N) (6.4 kg/d) or low (L) (3.2 kg/d) milk feeding level until weaning at 8 weeks. In total, 64 new born HF calves in 8 male and 8 female blocks of 4 were used in a 2 × 2 factorial design. All calves received 6.4 kg/d of cow's whole milk (M) from d 3 to d 13 of age. From d 14, half the calves (treatment L) received only 3.2 kg/d of M. All calves had free access to artificially-dried grass hay (9.8 MJ ME/kg DM), to water, and to either TRA or ALT concentrates from day 3. TRA contained 350 and ALT 107 g starch/kg DM, whereas NDF was 136 and 296 g/kg DM, respectively. Protein content (203 g/kg DM) was similar, but ME was lower in ALT than in TRA (11.2 vs. 12.2 MJ ME/kg DM). L-calves had higher concentrate intake than N-calves (P<0.001). TRA resulted in higher hay intake than ALT (P<0.01). L-calves had lower (608 g/d) ADG than N-calves (766 g/d) with no effect of concentrate type. At 8 weeks of age, size of reticulo-rumen (P<0.001) and weight of rumen epithelium (P<0.02) were lower in N- compared with L-calves. Rumen papillae length was not affected by treatments. In conclusion, if calves have access to a nutritious hay-product, feeding low- or high-starch concentrate will both result in normal rumen development and similar growth performance at the given milk feeding level.

Key Words: Dairy Calves, Calf Starters, Performance

T194 Rumen available soluble, insoluble and total structural and non-structural carbohydrates and protein and their ratios: Effect of barley variety and growth year. P. Yu* and K. Hart, *University of Saskatchewan, Saskatoon, SK, Canada.*

The objective of this study was to investigate rumen available soluble, insoluble and total protein (CP), estimated structural (SC) and non-structural carbohydrate (starch: ST), degradation characteristic ratio of six barley varieties during three consecutive growth years of 2003, 2004, 2005) in order to determine the magnitude of the differences between the varieties and growth years which affect optimizing a diet composition with regard to rumen fermentation. All the barleys were coarsely rolled with a roller gap of 1.12 mm. Measured degradation kinetics in fistulated dairy cows were soluble fraction (S: ST, CP), undegradable fraction (U: SC, CP), lag time (T0: SC, CP) and rate of degradation (Kd: SC, ST, CP) of the insoluble but degradable fraction (D: SC, ST, CP). Rumen available soluble, insoluble, and total N, structural and non-structural carbohydrate and rumen degradation characteristic ratio were determined using the Rumen Degradation Ratio System. Based on the measured kinetics, degradation ratios were calculated between the total rumen available N and carbohydrates (FN/FCHO), rumen available soluble N and carbohydrates (SN/SCHO), and rumen available insoluble N and carbohydrates (EN/ECHO). The ratios showed significant differences among the varieties in FN/FCHO, ranging from 16.6 to 19.0 g/kg (P<0.01), no differences in SN/SCHO (P>0.05) with an average of 4.9 g/kg. The EN/ECHO was tended to be significant among the varieties (P=0.069) ranging from 18.4 to 21.3 g/kg. Also the year affected FN/FCHO (P<0.01) and EN/ECHO (P<0.01) ranging from 15.3 to 18.6 g/kg and 17.0 to 21.4 g/kg, respectively, but no effect on

SN/SCHO with an average of 4.8 g/kg. In conclusion, both the barley variety and growth years significantly affect rumen degradation kinetics of protein, estimated structural and non-structural carbohydrates. There were significant differences in FN/FCHO ratio (average 17.2 g N per kg CHO) among the barley varieties.

Key Words: Degradation Ratio, Barley Varieties, Growth Year

T195 Effects of dietary starch and unsaturated fat with Rumensin on milk fat depression in lactating dairy cattle. M. E. Van Amburgh*¹, J. L. Capper¹, G. D. Mechor², and D. E. Bauman¹, ¹*Cornell University, Ithaca, NY*, ²*Elanco Animal Health, Greenfield, IN.*

This experiment investigated the effects of starch level, polyunsaturated fatty acids (PUFA) from corn oil and Rumensin (Elanco Animal Health, Greenfield, IN), and their interactions on milk fat synthesis and fatty acid profile. Eighty Holstein cows were assigned to eight treatments within a randomized, blocked design with cross-over on oil addition. Cows were housed in tie stalls and fed ad libitum TMR for approximately 10% refusals. Each treatment consisted of three 21-day periods: in the first period a high- (267 g/kg DM) or low- (203 g/kg DM) starch TMR was fed, followed by the addition of Rumensin (13 mg/kg DM) and/or corn oil at 1.2% DM (280 to 310 g/d); this provided eight different diets formulated for an average DM intake of 22.9 kg/d in period two. In the third 21-day period, cows randomized to diets containing corn oil were switched to diets without corn oil, and vice versa. Data were analyzed using a mixed model approach and the model included period, random effects of cow and fixed effects of starch, Rumensin and oil and their interactions. Dry matter intake and milk yield were increased (P<0.01) in cows fed diets with added corn oil. Further, the addition of corn oil was the primary dietary factor responsible for the observed milk fat depression (MFD) 3.35 versus 3.05% (P<0.004). Milk fat concentration decreased by approximately 12% with the addition of corn oil and 16% with the addition of both Rumensin and corn oil. Rumensin did not induce milk fat depression in cows fed either high or low starch diets (P>0.05), but increased milk protein concentration from 2.99 to 3.07 (P<0.03). Cows fed the high starch diets also had greater milk protein concentration and yield (P<0.04). Comparing the milk fat concentration of t-10, c-12 18:2 of cows with MFD with previously reported data and equations related to MFD, the fatty acid profiles suggest that this CLA isomer was primarily responsible for the milk fat depression observed in this study.

Key Words: Rumensin, Milk Fat Depression, CLA

T196 Effects of conventional or brown mid rib hybrid silage fed at two levels on intake, milk yield and composition, and rumen fermentation of dairy cows. T. D. Edwards*, G. A. Varga, R. H. Chung, V. A. Ishler, and M. Martinez, *The Pennsylvania State University, University Park.*

The objective of this study was to evaluate the effects of Brown Mid Rib (BMR) vs. conventional corn silage fed at two levels on production and rumen fermentation. Eight lactating (DIM=160; four rumen-cannulated) Holstein dairy cows were used in a replicated 4x4 Latin-Square design with 2x2 factorial dietary arrangement (silage type and level). The diets were formulated to contain either 35 or 50% of ration DM from corn

silage, using conventional (CONV) and BMR genotype silage. The diets contained 16% CP, 34% NDF and 28% forage NDF; DM basis. Each experimental period was 14 d, 7 d adaptation and 7 d sampling. Daily milk weights were collected, with sampling from four consecutive milkings the last two days of each period for components. Rumen samples were taken at set points over the last 24 hours of the sampling period. Intake was higher (level effect: $P \leq 0.01$) for cows consuming the 35% vs. 50% level of corn silage inclusion (28.2 vs. 26.4 kg/d). There was an interaction ($P \leq 0.01$) on DMI such that cows on the BMR silage maintained DMI (27.5 kg/d) on both levels of corn silage inclusion while those provided CONV reduced DMI (28.8 vs. 25.4 kg/d). Cows fed the BMR corn silage at 50% produced significantly more milk (corn silage type effect: $P \leq 0.05$) than cows fed the CONV hybrid at 50% (48.6 vs. 43.64 kg/d). Efficiency for converting feed to milk was greater (level effect: $P \leq 0.05$) for 50% vs. 35% inclusion rate (1.76 vs. 1.67, respectively). Yields or percentages of milk fat, protein, and lactose were not significantly different across diets. Rumen pH and ammonia concentration were similar across treatments. No differences in VFA profiles were observed except that concentrations of isobutyrate and isovalerate were higher (corn silage type effect: $P \leq 0.05$) for cows fed CONV vs. BMR corn silage. Feeding BMR corn silage at 50% of ration DM did not affect DMI and maintained milk yield compared with CONV corn silage. Efficiency of converting feed to milk was affected more by the level of corn silage inclusion in the ration than type.

Key Words: Conventional Silage, BMR, Silage Hybrid

T197 The effect of dietary sucrose on dry matter intake, plasma metabolites, and lactation performance for Holstein cows during the first 4 weeks of lactation. G. B. Penner* and M. Oba, *University of Alberta, Edmonton, Alberta, Canada.*

This study was conducted to determine the effect of dietary sucrose concentration during early lactation on dry matter intake (DMI), plasma metabolites, and lactation performance. Fifty-three Holstein cows free of clinically diagnosed transition disorders were used in this study. Cows were fed one of two experimental diets immediately after parturition which contained either 0% (LS) or 4.5% sucrose (HS). Diets consisted of 40% barley silage, 10% alfalfa hay, and 50% of a common concentrate mix which differed in the sucrose concentration by including either sucrose plus urea or cracked corn grain. Both diets were formulated to contain 23.2% forage NDF and 18.7% CP. Data and samples were collected over a 3-d period each in wk 2, 3, and 4 of lactation. Milk yield and composition data were analyzed for wk 3 and 4 only. Dry matter intake was not affected by treatment, averaging 17.4 kg/d. Plasma glucose concentration tended ($P = 0.07$) to be higher for LS compared to HS treatment (54.9 vs. 52.5 mg/dl). A parity \times wk interaction ($P = 0.03$) was detected for plasma glucose: multiparous cows had lower plasma glucose than primiparous cows (51.1 vs. 56.2 mg/dl); however, plasma glucose increased from wk 2 to wk 4 (48.5 to 58.0 mg/dl) for multiparous cows, whereas there was no change in the plasma glucose concentration for primiparous cows. A parity \times treatment interaction was detected ($P = 0.02$) for plasma β -hydroxybutyrate (BHBA) concentration; multiparous cows fed HS (30.9 mg/dl) had higher plasma BHBA than multiparous cows fed LS (11.3 mg/dl) and primiparous cows fed HS (15.3 mg/dl) and LS (14.7 mg/dl). Milk and crude protein yields were not affected by treatment averaging 38.3 and 1.13 kg/d respectively. Feeding HS increased the milk fat yield (1.52 vs. 1.33 kg/d; $P = 0.02$) and tended to increase the milk fat concentration (3.91 vs. 3.60%; $P = 0.09$) compared to LS. These data indicate that feeding sucrose during

early lactation does not affect DMI or milk yield but can increase the yield and concentration of milk fat.

Key Words: Sucrose, Transition Period

T198 Efficacy of glycerol as a replacement for lactose in calf milk replacer. R. A. Ebert*¹, G. M. Willis², and J. K. Drackley¹, ¹*University of Illinois, Urbana,* ²*MSC, Dundee, IL.*

Glycerol (glycerin) is increasingly available from biodiesel manufacture and edible oil refining and has been used successfully in diets for chickens, pigs, and adult cattle; however, no information is available on its nutritional value in young calves. Our objective was to determine the effects on calf growth and health when glycerol replaced a portion of lactose in milk replacer. Holstein calves (6 male, 6 female) born at the University of Illinois dairy unit were assigned alternately to each of 2 treatments (24 calves total): control milk replacer or milk replacer supplemented with 15% glycerol. The experimental base milk replacer contained greater protein, fat, minerals, and vitamins so that when glycerol was added the composition would be the same as control, except that glycerol replaced some lactose. Calves were housed in individual hutches bedded with straw and had water freely available; no starter was offered until d 36. Calves were fed milk replacers twice daily from d 3 of life. Milk replacers contained 28% protein (all from whey proteins), 2.6% lysine, and 15% fat. Control milk replacer contained 40% lactose; glycerol milk replacer contained 25% lactose. Both replacers were reconstituted to 15% solids. Glycerol (liquid) was added to reconstituted base milk replacer at each feeding. During wk 1 milk replacers were fed at a rate of 0.25 Mcal/kg metabolic BW (about 1.5% of BW daily as powder) and from wk 2 - 6 at of 0.30 Mcal/kg metabolic BW (about 2% of BW daily). Starter was offered beginning on d 36. Milk replacer offered was reduced by half on d 43; calves were weaned at d 49. Measurements of BW and stature were made weekly through d 56. Calf BW through d 35 did not differ significantly between treatments (0.68 vs. 0.64 kg/d for controls and glycerol, respectively). Stature measurements (withers height, body length, heart girth) and measures of health (fecal scores, medical treatments) did not differ between treatments. Glycerol could be an acceptable replacement for at least 37.5% of the total lactose in milk replacer if economically favorable.

Key Words: Glycerol, Milk Replacer, Calves

T199 Effects of varying forage proportion and particle length on supply of amino acids. W. Z. Yang and K. A. Beauchemin*, *Research Center, Agriculture and Agri-Food Canada, Lethbridge, AB, Canada.*

Forage proportion and particle length are the main factors that contribute physically effective fiber (peNDF) to the diet, which helps prevent ruminal acidosis. This study aimed to investigate whether the supply of AA to the duodenum and digestibility of those AA in the intestines vary with particle length and forage proportion. Four ruminally and duodenally cannulated lactating cows were used in an experiment designed as a 4 \times 4 Latin square with a 2 \times 2 factorial arrangement of treatments. Four diets were formulated using two cuts of alfalfa silage, short (7.9 mm) and long (19.1 mm), combined with two ratios of forage to barley grain concentrate (35:65 and 60:40, DM basis). The content of N was 20.2% and 21.7% (DM basis), respectively, for low and high forage

diets. Intake of AA (range of 2.9 to 3.3 kg/d) was not affected by forage proportion although DMI was higher with low (20.6 kg/d) forage than with high (18.3 kg/d) forage diets. Overall, flows of microbial and total AA at the duodenum, and digestibility of AA (% of duodenal flow) in the intestine were higher with low forage (1.8 kg/d, 3.3 kg/d, and 67.6%, respectively) than with high forage diets (1.4 kg/d, 2.5 kg/d, and 63.6%, respectively). However, varying forage particle length did not affect the flow (short vs. long; 2.94 vs. 2.89 kg/d) or intestinal digestibility (short vs. long; 66.2 vs. 65.0%) of AA. The profiles of individual essential AA in the duodenal digesta were not affected by the dietary treatments. The proportion of duodenal essential AA (40.9% of total AA) was higher than the original diets (36.9%). The increase of essential AA proportion in the duodenal protein resulted from the higher essential AA in the microbial protein (45.9%) that flowed to the duodenum. These results indicate that increasing forage proportion to increase dietary peNDF reduced overall AA supply because flow and intestinal digestibility of AA were reduced. However, increasing particle length had only marginal effects on AA supply.

Key Words: Forage Proportion and Particle Length, Amino Acids, Dairy Cows

T200 Effects of barley grain processing and source of supplemental dietary fat on nutrient digestion and microbial protein synthesis in dairy cows. G. N. Gozho*, M. R. Hobin, and T. Mutsvangwa, *University of Saskatchewan, Saskatoon, Saskatchewan, Canada.*

The objective was to determine the effects of method of barley grain processing and source of supplemental fat on ruminal nutrient digestion, duodenal nutrient flow, and ruminal microbial protein synthesis. Four Holstein cows (656 kg BW; 80 DIM) fitted with ruminal and duodenal cannulae were used in a 4 × 4 Latin square design with 28-d periods and a 2 × 2 factorial arrangement of dietary treatments. Treatments were dry-rolled barley + whole canola seed (DC), pelleted barley + whole canola seed (PC), dry-rolled barley + flaxseed (DF), and pelleted barley + flaxseed (PF). Cows fed dry-rolled barley consumed 1.8 to 3.5 kg/d more DM compared to those fed pelleted barley. Ruminal pH and NH₃-N concentration were higher in cows fed dry-rolled barley compared to those fed pelleted barley. Cows fed dry-rolled barley consumed 1.8 to 3.5 kg/d more DM compared to those fed pelleted barley; consequently, intakes of OM ($P = 0.02$), NDF ($P = 0.007$) and ADF ($P = 0.03$) were higher in cows fed dry-rolled barley. Starch intake tended to be higher ($P = 0.08$) in cows fed dry-rolled compared to pelleted barley. Ruminal digestibility coefficients for starch, OM, and ADF were not affected by treatment; however, ruminal NDF digestibility tended to be higher for cows fed dry-rolled compared to pelleted barley. Duodenal flow of starch was greater ($P = 0.003$) in cows fed dry-rolled compared to those fed pelleted barley. Duodenal flow of microbial N was unaffected by diet,

and was 267, 287, 260 and 252 g/d in cows fed DC, PC, DF, and PF diets, respectively. The efficiency of microbial N synthesis (expressed as g microbial N per kg of OM truly digested in the rumen) were not affected by diet, and were 25.3, 28.8, 23.9 and 22.7 for cows fed DC, PC, DF, and PF diets, respectively. Attempts in our study to shift starch digestion to the rumen through barley grain pelleting were negated by a higher DM intake in cows fed dry-rolled barley diets.

Key Words: Dairy Cow, Duodenal Nutrient Flow, Microbial Protein Synthesis

T201 Wheat, barley, or corn grain based starters with different alfalfa meal levels for Holstein calves. M. Noroozi¹, H. Amanlou¹, G. R. Ghorbani², and A. Nikkhah^{*1,3}, ¹Zanjan University, Zanjan, Iran, ²Isfahan University of Technology, Isfahan, Iran, ³University of Illinois, Urbana.

Wheat grain (WG) has recently become more available in Iran's feed market, thus attracting new interest to its major use in ruminant diets. Given WG's lower cost and higher starch and protein fermentability than corn and barley grains, our objective was to determine the effects of offering either corn, barley, or WG based starters at three levels of alfalfa meal (AM) on weight gain, feed intake, blood metabolites, fecal properties and calf health. Following 3 days of colostrum and transition milk feeding, 54 Holstein calves were assigned to nine starters and received 4 L of whole milk daily at 0900 h and 2100 h from day 4 until day 70 of age in individual hutches. Treatments were starters made of either ground corn, barley or WG (47.9-60.9%) with 0, 5 or 10% AM, on a dry matter basis. Starters were formulated to maintain crude protein (21% of DM), NEm (2.20-2.44 Mcal/kg) and NEg (1.67-1.86 Mcal/kg) as comparable as possible among treatments. Body weight was recorded weekly between 1400 and 1500 h. Feces form, rectal temperature, diarrhea incidence, and general calf health were recorded twice daily. DMI (57.2 vs 62.2 and 62.8 kg), weight gain (33 vs 37.3 and 38.3 kg), and fecal firmness were lower ($P < 0.05$) in WG fed calves than in other calves, respectively. The type of grain did not affect blood metabolites and feed conversion ratio. Inclusion of AM at 5 and 10% reduced ($P < 0.05$) weight gain (36.7 and 32.8 vs 38.9 kg) and blood glucose (114 and 113 vs 129 mg/dl), increased feed conversion ratio (1.66 and 1.94 vs 1.65) and fecal firmness (1.81 and 1.78 vs 1.97; 1 = quite firm, 5 = watery), but did not affect blood total proteins and urea, compared to AM free starters. Results suggest that under current calf raising practices, WG may be used as the sole dietary cereal in calf starters when corn and barley are less available. These data did not support a necessity of using >5% AM in the starter for a superior weaning performance. Whether a blend of WG with other cereals may optimize rumen development and lower weaning age warrants future studies.

Key Words: Cereal, Alfalfa, Calf