Forages and Pastures I

182 Reduced ferulate cross link concentration is associated with improved fiber digestibility of corn stover at silage maturity. H. G. Jung*[1,2] and R. L. Phillips[2], [1]*USDA-ARS*, *St. Paul, MN*, [2]*University of MInnesota*, *St. Paul*.

Ferulate cross linking of lignin to arabinoxylan is correlated with fiber digestibility in perennial cool-season grasses; however, similar data have not been reported for warm-season grasses. Our objective was to determine if ferulate cross link concentration is associated with fiber digestibility in corn stover at silage maturity. Four mutant corn lines selected for low ferulate ester concentration in seedling leaves, parental control line, and four backcross lines were grown in a replicated field trial and evaluated for NDF, ADL, and ferulate cross link concentrations, and in vitro NDF digestibility (IVNDFD) of leaf blades, sheaths, and stems at silage maturity. Low ferulate corn lines had lower concentrations of NDF, and less ADL and ferulate cross links as a proportion of NDF, and higher 24- and 96-h IVNDFD than did the control line. Backcross lines were intermediate for all traits. While growth environment (year and location) influenced all forage quality traits, corn lines generally maintained differences across environments. Ferulate cross link concentration was negatively correlated with 24- and 96-h IVNDFD for leaves (r = -0.52 and -0.92, respectively), sheaths (r = -0.47 and -0.52, respectively), and stems (r = -0.71 and -0.78, respectively). NDF concentration was always correlated with IVNDFD (r = -0.38 to -0.95) and ADL was similarly correlated with IVNDFD except for leaves. Ferulate cross link concentration was correlated with NDF (r = 0.81, 0.68, and 0.75 for leave, sheath, and stem, respectively) and ADL (r = 0.41 and 0.84 for sheath and stem, respectively) concentration. Correlations of NDF and ADL with ferulate cross links indicate the inter-relatedness of forage quality traits, and preclude concluding that ferulate cross links are a mechanism that controls IVNDFD. However, because ferulate esters are required for cross link formation and the mutant corn lines selected for low seedling ferulate esters had reduced ferulate cross links as predicted, our data support the hypothesis that ferulate cross links modify cell wall structure such that digestibility is altered.

Key Words: Ferulate Cross Links, Fiber Digestibility, Corn Silage

183 Evaluation of alfalfa hays with down-regulated lignin biosynthesis. D. R. Mertens*[1] and M. McCaslin[2], [1]*US Dairy Forage Research Center*, *Madison, WI*, [2]*Forage Genetics International*, *Nampa, ID*.

Our objective was to assess the impact of down-regulating the COMT or CCOMT enzymes in the lignin biosynthesis pathway on the intake and digestibility of alfalfa. Two genetic lines were developed: one with COMT down-regulated or not (COMTnull) and the other with CCOMT down-regulated or not (CCOMTnull). Hays were harvested at first-cutting in ID. Amylase-treated NDF organic matter (aNDFom), ADF and ADL were (% of DM): 38.2, 31.3, & 5.3 for COMT; 39.0, 32.0, & 5.8% for COMTnull; 39.4, 32.6, & 5.2 for CCOMT; 39.4, 32.8, & 5.9 for CCOMTnull; 38.4, 23.7, & 1.3 for corn silage; and 7.5, 2.6, & 0.2 for the concentrate mixture (Mix). Chopped hays were fed as hay-only and in TMR containing 50% hay, 10% corn silage and 40% Mix to young lambs during four 5-week trials. Lambs were blocked by BW and 3 were assigned to each treatment. Digestibility and intake were determined on a reference alfalfa as a covariate. Digestibility was measured at ad libitum (AL) and restricted intakes (RESTR = ~1.8% BW/d). Data was analyzed using GLM: hays were compared using a split-plot in time design with BlockXTreatment as the error variance and TMR were compared using a replicated Latin-square design with the residual as the error variance. Down-regulating COMT and CCOMT lowered ADL with little change in other components. When hay-only was fed at AL intakes, COMT had greater DMD (.675 vs .645) and greater NDFD (.575 vs .491) than its null ($P<.05$). Down-regulated CCOMT yielded smaller differences in DMD (.653 vs .637) and NDFD (.501 vs .464) that were significant when adjusted for the covariate. Intake of NDF (%BW/d) was greater for COMT than its null (1.60 vs 1.42), but not for CCOMT (1.38 vs 1.32). Responses were similar during RESTR, but generated higher probabilities. Differences in DMD and NDFD were less when hays were fed in TMR and only those for COMT were significant. In TMR, NDFD was lower than hay-only. We conclude that down-regulating COMT and CCOMT in alfalfa results in improved digestibility and this effect is negatively affected by feeding hays in TMR.

Key Words: Alfalfa, Digestibility, Lignin

184 Lactating cow responses to alfalfa hays with down-regulated lignin biosynthesis. D. Weakley*[1], D. R. Mertens[2], and M. McCaslin[3], [1]*LongView Animal Nutrition Center*, *Gray Summit, MO*, [2]*US Dairy Forage Research Center*, *Madison, WI*, [3]*Forage Genetics International*, *Nampa, ID*.

The objective was to assess the impact of down-regulating the COMT or CCOMT enzymes of the lignin biosynthesis pathway in alfalfa on production, intake and digestibility responses by lactating dairy cows. Two genetic lines were developed: one with COMT down-regulated or not (COMTnull) and the other with CCOMT down-regulated or not (CCOMTnull). Hays were harvested at first-cutting in ID. Chopped hays were fed in TMR containing 50% hay, 10% corn silage and 40% of a concentrate mixture containing finely ground corn, soybean meal and fat supplementation as the major ingredients. Ration CP, NDF, and ADF were (% of DM): 18.1, 31.1, & 20.2 for COMT; 18.4, 29.3, & 19.6% for COMTnull; 18.1, 31.2, & 20.6 for CCOMT; and 18.3, 31.1 & 20.6 for CCOMTnull. Twelve multiparous cows were used to compare each down-regulated treatment to its null in a two-period crossover design (3-week periods) in two separate experiments. Cows were blocked into two levels of milk production and three cows of each block were assigned to the treatment or null in period 1. Data was analyzed using GLM: treatments were compared within genetic lines using a replicated crossover design with the residual as the error variance. Production of FCM (kg/d) was higher for COMT than its null (38.5 vs 37.3) at $P<.10$, but was not different between CCOMT and its null (38.4 vs 39.4). Compared to nulls, milk fat (%) was not different for COMT (3.05 vs 3.06) or CCOMT (3.35 vs 3.40) nor was DMI (kg) different for COMT (23.2 vs 23.2) or CCOMT (26.0 vs 25.9). Digestibility of NDF was increased by down-regulation of both COMT (.535 vs .425) and CCOMT (.486 vs .445) at $P<.01$. The .97 kg additional digestible matter in the COMT diet compared to its null resulted in 1.3 kg more milk (3.05% fat), but the .36 kg greater digestible matter in CCOMT did not increase milk yield. We concluded that down-regulating COMT and CCOMT in alfalfa results in improved fiber digestibility and this effect appears to be greater for COMT than for CCOMT.

Key Words: Alfalfa, Digestibility, Lignin

185 Digestibility, milk fatty acid profile, and plasma amino acids in lactating dairy cows fed alfalfa cut at sundown or sunup. A. F. Brito*[1], G. F. Tremblay[2], C. Benchaar[1], A. Bertrand[2], Y. Castonguay[2], G. Bélanger[2], R. Michaud[2], H. Lapierre[1], D. R. Ouellet[1], H. V. Petit[1], and R. Berthiaume[1], [1]*Dairy & Swine R&D Centre, Agriculture & Agri-Food Canada*, *Sherbrooke, QC, Canada*, [2]*Soils & Crops R&D Centre, Agriculture and Agri-Food Canada*, *Quebec, QC, Canada*.

Alfalfa (*Medicago sativa*) cut at sundown has been shown to contain more total nonstructural carbohydrates (TNC) than that cut at sunup. Our objective was to test the effects of cutting alfalfa at sundown (PM) vs.sunup (AM) on digestibility, milk fatty acid (FA), and concentration of plasma AA. Alfalfa was conserved as baleage (530 g/kg DM) into individually wrapped large rectangular bales. Sixteen multiparous lactating Holstein cows were randomly assigned to 1 of 2 treatments: PM or AM alfalfa in a crossover design. Cows were fed only baleage that contained (g/kg DM): 179 vs. 189 CP and 128 vs. 105 TNC for PM vs. AM, respectively. Feces (total collection) and milk were collected for 5 consecutive days (n = 8 cows). Total tract OM digestibility was greater in cows fed PM while the opposite was observed for N. No differences between treatments were found for DM and NDF digestibilities. Minor changes in milk FA profile were observed as C14:1, C16:1, and C20:4n6 were all significantly lower in cows fed PM. Feeding PM baleage increased plasma concentration of Lys, Met ($P = 0.07$), nonessential AA (NEAA), and total AA (TAA) but had no effect on branched-chain AA (BCAA) and essential AA (EAA). In summary, cows fed PM baleage had higher OM digestibility and plasma concentration of Lys, NEAA, and TAA.

Table 1.

	Time of cut			
Item	PM	AM	SED	*P*-value
DM Intake, kg/d	19.2	18.5	0.41	0.11
DM Digestibility, %	64.3	63.3	0.59	0.16
OM Intake, kg/d	17.1	16.3	0.36	0.07
OM Digestibility, %	65.4	63.7	0.46	0.01
NDF Intake, g/d	7.45	7.39	0.18	0.76
NDF Digestibility, %	47.3	48.0	0.97	0.50
N Intake, g/d	556	569	11.5	0.29
N Digestibility, %	68.7	69.9	0.51	0.05
Plasma AA, μ*M*				
Lys	98.9	82.6	6.20	0.02
Met	27.7	25.4	1.18	0.07
NEAA	1,183	1,074	28.0	<0.01
TAA	2,118	1,970	57.6	0.02

Key Words: Alfalfa, Diurnal Cut, Dairy Cows

186 Effects of cutting alfalfa at sundown or sunup on omasal flow of nutrients in lactating dairy cows. A. F. Brito*[1], G. F. Tremblay[2], C. Benchaar[1], A. Bertrand[2], Y. Castonguay[2], G. Bélanger[2], R. Michaud[2], H. Lapierre[1], D. R. Ouellet[1], and R. Berthiaume[1], [1]*Dairy & Swine R&D Centre, Agriculture & Agri-Food Canada*, *Sherbrooke, QC, Canada*, [2]*Soils & Crops R&D Centre, Agriculture & Agri-Food Canada*, *Quebec, QC, Canada*.

Alfalfa (*Medicago sativa*) cut in the afternoon has been shown to contain more total nonstructural carbohydrates (TNC) than that cut in the morning. Our objective was to investigate the effects of diurnal cut (PM vs. AM) on omasal flow of nutrients. Alfalfa was conserved as baleage (530 g/kg DM) into individually wrapped large rectangular bales. Eight multiparous lactating Holstein cows fitted with ruminal cannulae were randomly assigned to 1 of 2 treatments: PM or AM alfalfa in a crossover design. Cows were fed only baleage that contained (g/kg DM): 179 vs. 189 CP and 128 vs. 105 TNC for PM vs. AM, respectively. Cobalt-EDTA and $YbCl_3$ were continuously infused into the rumen to estimate digesta passage of nutrients using the omasal sampling technique. Intakes and omasal flows of DM and OM tended to be higher in cows fed the PM compared to the AM baleage suggesting increased availability of nutrients to the animals. Intake of N and omasal flows of N fractions did not differ significantly between treatments. The same was observed for the omasal flows of Lys, Met, branched-chain AA (BCAA), essential AA (EAA), nonessential AA (NEAA), and total AA (TAA). In conclusion, feeding alfalfa baleage with contrasting TNC levels had no effect on omasal flow of N compounds in lactating dairy cows.

Table 1.

	Time of cut			
Item	PM	AM	SED	*P*-value
DM Intake, kg/d	19.8	18.9	0.42	0.09
DM Flow, kg/d	13.4	12.7	0.29	0.06
OM Intake, kg/d	17.5	16.7	0.38	0.07
OM Flow, kg/d	9.61	9.20	0.20	0.09
N Intake, g/d	560	574	12.2	0.30
N Flow, g/d	451	458	12.4	0.57
Ammonia N Flow, g/d	6.38	5.88	0.71	0.51
NAN Flow, g/d	444	452	12.7	0.56
Lys Flow, g/d	134	138	5.9	0.52
Met Flow, g/d	49.1	50.1	2.29	0.68
EAA Flow, g/d	894	926	42.5	0.48
NEAA Flow, g/d	736	761	28.5	0.42
TAA Flow, g/d	1,629	1,687	71.0	0.45

Key Words: Alfalfa, Diurnal Cut, Omasal Flow

187 Which native Sicilian pasture plants make the difference for milk aroma quality? I. Schadt*[1], T. Rapisarda[1], G. Belvedere[1], F. La Terra[1], G. Azzaro[1], P. J. Van Soest[2], G. Licitra[3,1], and S. Carpino[1], [1]*CoRFiLaC, Regione Siciliana*, *Ragusa, Italy*, [2]*Cornell University*, *Ithaca, NY*, [3]*D.A.C.P.A., University of Catania*, *Catania, Italy*.

It has been shown that cheeses produced from cows consuming native pastures versus total mixed ration (TMR) differ in aroma compounds and sensory properties (Carpino et al. 2004, J. Dairy Sci. 87:816-830; Carpino et al. 2004, J. Dairy Sci. 87:308-315). In the present study *Anthemis arvensis*, *Calendula arvensis, Sinapis arvensis*, *Chrysanthemum coronarium*, and Geraniaceae spp. were evaluated individually for their capacity to influence milk aroma. The plant species were collected at flowering age, and part of the forage was dried to produce hay. Single doses of fresh and dried forage were fed individually *ad libitum* to two dairy cows in mid lactation. The cows were adapted to a TMR ration and TMR was given to the cows, at the middle and the end of the experiment as controls. A time of seven days between treatments was maintained. Animals were held off feed for five hours before and after treatments. Feed intake was recorded by weighing provided forage, TMR and refusal. Milk was sampled the day before and the same day of the

treatment during the evening milking before and after feeding. Aroma profiles of the milk samples were analyzed with a MS-based Electronic Nose (SMartNose), and differences were statistically evaluated using Principal Components Analysis. SMartNose showed different aroma profiles for milk samples collected after forage provision, before and after TMR feeding. With exception of *Sinapis arvensis*, the milk samples obtained from fresh forage were different from those obtained from hays. In conclusion, all examined forage species, both fresh and dried, had impact on milk aroma as detected by SMartNose. Feeding of the fresh forage may have a different effect compared to the respective hay.

Key Words: Pasture, SMartNose, Milk Aroma

188 Effects of supplementing tanniferous sainfoin hay on nitrogen metabolism of grass-fed dairy cows. F. Dohme*[1], A. Scharenberg[1], and M. Kreuzer[2], [1]*Agroscope Liebefeld-Posieux, Research Station ALP, Posieux, FR, Switzerland*, [2]*ETH Zurich, Institute of Animal Science, Zurich, ZH, Switzerland*.

Condensed tannins (**CT**) are able to form complexes with feed proteins. This property may reduce the metabolic stress of lactating cows fed grass-based diets which often result in a high ammonia load. In a replicated 3 × 3 Latin Square arrangement, 6 ruminally cannulated Holstein cows were randomly assigned to 3 treatments. In treatment **GF** cows received only cut pasture grass, whereas in treatments **GH** and **SH** 3 kg of hay obtained either from grass-clover or sainfoin swards, respectively, were additionally supplied. From a milk yield of 22 kg/d onwards, cows were fed 0.5 kg/d of barley per kg additionally produced milk. Each of the 3 consecutive experimental periods consisted of a 14-d adaptation and a 7-d balance period where feed intake was recorded daily and feces and urine were collected quantitatively. On the last d of each balance period ruminal fluid and blood were sampled every 4 h from 0700 to 1900. Data were analyzed by the MIXED procedure of SAS and means were separated using the PDIFF option. Intake of total DM (19.6 kg/d) and grass DM (14.3 kg/d) did not differ among treatments. Although the amount of hay DM consumed in treatment SH (1.27 kg/d) was less than offered and lower than in treatment GH (1.83 kg/d), the higher CP content of sainfoin hay (201 g/kg DM) compared to grass-clover hay (131 g/kg DM) and fresh grass (124 g/kg DM) caused the highest daily N intake with SH (412 g) followed by GH (405 g) and GF (392 g; $P<0.05$). Concomitantly, fecal N excretion was higher ($P<0.05$) with SH compared to GF and GH resulting in the highest ($P<0.05$) proportion of fecal N in total N intake. In contrast, no ($P<0.05$) differences were observed in excretion of urinary N. Ruminal ammonia and plasma urea concentration were lowest ($P<0.05$) with GH compared to GF and SH. Plasma urea concentration decreased over the day ($P<0.001$). In conclusion, the lack of positive effects of CT might be explained by their relatively low content in sainfoin used (55 g/kg DM) or the low proportion of sainfoin in the total diet or both. Moreover, in this study ammonia load might be too low as that CT could have had an impact.

Key Words: Condensed Tannins, Dairy Cow, Nitrogen Balance

189 Modeling manure OM and N composition of dairy cows fed grass silage based diets. J. Dijkstra*[1], A. Bannink[2], E. A. Lantinga[3], and J. W. Reijs[4], [1]*Animal Nutrition Group, Wageningen University, Wageningen, The Netherlands*, [2]*Animal Sciences Group, Wageningen UR, Lelystad, The Netherlands*, [3]*Biological Farming Systems Group, Wageningen University, Wageningen, The Netherlands*, [4]*Agricultural Economics Research Institute, Wageningen UR, Wageningen, The Netherlands*.

Nitrogen pollution in dairy farming may be lowered by reducing N output in excreta and by optimizing manure C:N ratio and N composition. An extant mechanistic model of digestion and fermentation processes was modified to simulate the fecal and urinary composition of dairy cattle fed grass silage (*Lolium perenne* L.) based diets. Total N excretion was partitioned into three fractions representing availability of N to plants, viz. immediately available N (N_M; mainly urea), easily decomposable N (N_E; urinary non-urea N, endogenous N and microbial N) and resistant N (N_R; N in undigested feed). Four different types of grass silages were explored at high (HF) and low (LF) N fertilization level and early (EC) or late (LC) cutting. For each grass silage, 10 supplementation strategies that differed in level and type of supplement were studied. Simulated urinary N excretion showed large variation between silages, but variation in simulated fecal N excretion was small. Urinary N excretion and the N_M fraction decreased considerably with lowered fertilization level and, to a smaller extent, with delayed cutting. The simulated N_E and N_R excretion (in g/d) were relatively constant though. A lower fertilization level or delayed cutting increased simulated manure C:N ratio.

Table 1. Simulated excretion and manure composition (means across 10 supplementation strategies)

	HFEC	LFEC	HFLC	LFLC	Range
Milk N, % feed N	24.9	30.8	26.7	32.7	22.6 - 37.1
Manure C:N	4.6	6.3	6.5	8.8	3.4 - 10.6
Total OM excretion, kg/d	5.0	4.7	5.4	5.2	3.7 - 6.3
Urine OM excretion, kg/d	0.9	0.5	0.6	0.4	0.2 - 1.1
Total N excretion, g/d	483	337	372	268	211 - 558
Urine N excretion, g/d	323	180	218	123	81 - 388
N_M, % excreted N	59.2	45.5	50.8	37.5	29.3 - 63.5
N_E, % excreted N	29.7	37.9	34.4	43.7	26.9 - 48.9
N_R, % excreted N	11.1	16.6	14.8	18.8	9.6 - 21.8

Key Words: Manure Composition, N Efficiency, Modeling