

Forages and Pastures: Harvested Forages and Forage Quality

452 Lamb and cow performance when fed corn silage that has reduced ferulate cross linking. H. G. Jung^{*1,3}, D. R. Mertens², and R. L. Phillips³, ¹USDA-ARS, St. Paul, MN, ²USDA-ARS, Madison, WI, ³University of Minnesota, St. Paul.

Ferulate-mediated lignin/hemicellulose cross linking in grasses reduces in vitro NDF digestibility (IVNDFD). Impact of ferulate cross linking on animal performance was examined in lamb digestibility and dairy cow performance trials using the seedling ferulate ester (*sfe*) corn mutant that reduces cross linking and improves IVNDFD. Digestibility of control (W23) and 2 near-isogenic *sfe* (M04-4 and M04-21) silages was determined with lambs fed ad lib and restricted. Each silage was fed to 4 lambs as the sole ingredient. The same silages were fed to lactating cows in 37% corn silage diets formulated for 29% diet NDF and 70% of NDF from corn silage. A 28-d lactation trial was conducted with 14 cows per diet. Feed intake and milk production were determined. Both trials were analyzed as a randomized complete block using PROC MIXED. Orthogonal contrasts were used to compare W23 to *sfe* lines combined and M04-21 only. The *sfe* silages had fewer ferulate cross links than W23 (0.96, 0.86, and 0.81% of NDF in W23, M04-4, and M04-21, respectively), but the *sfe* mutants had higher NDF and ADL, and lower starch concentrations than W23. The IVNDFD of M04-21 silage after 24-, 48-, and 96-h was greater than W23, while M04-4 IVNDFD was only greater after 24 h. Lamb ad lib silage intake was greater ($P < 0.05$) for W23 than *sfe* lines combined, but M04-21 did not differ from W23. Digestibility of DM was greater ($P < 0.05$) for W23 than *sfe* at ad lib but not restricted intake, whereas silages did not differ for NDF or starch digestibility at either intake. Lambs were less selective against NDF when fed *sfe* silages ad lib ($P < 0.05$) or restricted ($P < 0.10$). Intake (21.8, 23.4, and 23.3 kg/d for W23, M04-4, and M04-21, respectively) and milk production (38.9, 39.3, and 41.6 kg/d for W23, M04-4, and M04-21, respectively) were greater ($P < 0.01$) for cows fed the *sfe* containing diets. Diet refusals indicated cows selected less against NDF in the *sfe* diets than for W23 diets. The data suggest reduced ferulate cross linking in corn silage had a small positive impact on ruminant performance.

Key Words: ferulate, corn silage, NDF

453 Impact of brown midrib trait and seeding rate on chemical composition and in vitro gas production of pearl millet silage. F. Hassanat^{*1}, A. Mustafa², P. Seguin³, and R. Berthiaume¹, ¹Agriculture and Agri-Food Canada, Sherbrooke, QC, Canada, ²Department of Animal Science, McGill University, Montreal, QC, Canada, ³Department of Plant Science, McGill University, Montreal, QC, Canada.

The impact of brown midrib trait and seeding rate on chemical composition, and in vitro gas production of millet (*Pennisetum glaucum*) silage was investigated in a 2×3 completely randomized factorial block design. Regular (RM, variety CFPM101) and brown midrib (BM, variety CFPBMR) millet were seeded at rates of 5, 10, and 15 kg ha⁻¹. Forages were harvested at vegetative stage (pre boot, 2m average height, 8 fully developed leaves) and ensiled in mini-silos for 28 d. Chemical composition of silages was determined as well as in vitro gas production profiles using 24 h incubation in Ankom^{RF} gas production monitoring system. Michaelis-Menten model was used to estimate gas production parameters. Chemical composition of solid and liquid incubation residues was used for degradability calculations. Results showed that both millet cultivars produced well preserved silage with an average pH of 4.2 and 120 g kg⁻¹ lactic acid. Brown midrib millet silage contained

5.3% less neutral detergent fiber (NDF), and 32% less acid detergent lignin ($P < 0.05$) than RM. Treatments had no effect on crude protein content, which averaged 130 g kg⁻¹. Asymptotic gas production was similar between the 2 millet types, while degradation rate was 40% higher ($P < 0.05$) for BM than RM. Thus, brown midrib trait reduced ($P < 0.05$) time to degrade 50% and 75% of the silage substrate by 2 and 6 h, respectively. In vitro true dry matter degradability and NDF degradability were 3 and 5% higher ($P < 0.05$) for BM than RM silage. Acetic, propionic and butyric acid concentrations in the liquid residue were all higher ($P < 0.05$) for BM than RM. Microbial protein production efficiency per g substrate was 9% higher ($P < 0.05$) for BM than RM. This is supported by post incubation medium ammonia concentration, which was higher ($P < 0.05$) for RM than BM silage. Seeding rate had no impact on chemical composition or in vitro gas production parameters of millet silage. Quality of BM silage was superior to that of RM silage by providing more substrate for microbial growth and more volatile fatty acids for energy production.

Key Words: millet, brown midrib, in vitro gas production

454 Exogenous fibrolytic enzyme or anhydrous ammonia effects on digestion kinetics of steers fed bermudagrass harvested at two regrowth intervals. J. J. Romero^{*}, A. T. Adesogan, M. A. Zarate, O. C. M. Queiroz, J. H. Han, J. H. Shin, C. R. Staples, and W. F. Brown, University of Florida, Gainesville.

The objectives were to compare effects of fibrolytic enzyme (ENZ, Biocellulase A20) and anhydrous ammonia (AMN, 4% of DM) treatment of 5 and 13-wk regrowths of bermudagrass hay on digestion kinetics in steers. Six individually housed, ruminally-cannulated Brangus steers (BW 216 ± 6 kg) were used in an experiment with a 6×6 Latin square design with a 3 (additives) \times 2 (regrowth intervals, RI) factorial arrangement. Steers were fed hay in ad libitum amounts supplemented with 2 kg of sugar cane molasses and 0.8 kg of distillers grains daily. In each period, after 14 d of adaptation, ruminal liquid volume, dilution rate, VFA, NH₃-N, and pH were quantified and in situ ruminal DM degradation was measured in triplicate in steers fed the incubated hay. The 5-wk hay had a longer ($P < 0.001$) in situ lag time (2.8 vs. 1.5 h) and contained less ($P < 0.05$) soluble (12.7 vs. 13.6%) and indigestible (40.9 vs. 43.5%) fractions and more ($P < 0.001$) potentially digestible fraction (46.4 vs. 42.9%) than the 13-wk hay. Proportion (mol / 100 mol) of ruminal acetate was greater ($P = 0.002$; 58.3 vs. 56.5) and butyrate was lower ($P = 0.001$; 16.1 vs. 17.8) for steers fed the 5-wk vs. 13-wk hay. Ammoniation increased ($P < 0.05$) concentrations of total VFA (155 vs. 144 mM) and ruminal NH₃-N (15.1 vs. 11.4 mg/dl) and the potentially digestible fraction (50.3 vs. 42.7%) and decreased ($P < 0.05$) the molar proportion of propionate (17.9 vs. 19.1 mol / 100mol) and the indigestible fraction (34.6 vs. 45.3%). Ammoniation also increased the degradation rate of the 13 wk hay (7.4 vs. 5.6% / h; AMN \times RI interaction, $P = 0.04$). Enzyme treatment did not affect any of these measurements. Ruminal fluid volume, dilution rate and turnover time were unaffected by additives or RI. Ammoniation improved the digestion kinetics of the hays but enzyme application did not.

Key Words: forage, enzyme, ammonia

455 Effect of chopping or cubing on apparent digestibility of hay when fed to steers. R. Willcutt^{*1}, B. J. Rude¹, and J. Davis², ¹Animal & Dairy Sciences, Mississippi State University, Starkville, ²Agricultural & Biological Engineering, Mississippi State University, Starkville.

Resurged interest in pelleting (cubes) grass has been a result of the push to decrease reliance upon fossil fuels, thereby the cubes can be co-fired in coal furnaces to generate energy production. As such, these cubes may have a dual function that will allow grass producers to determine optimum marketing of cubes based upon economic incentive for either energy production or animal feed. The objective of this study was to evaluate the apparent digestibility of chopped or chopped and cubed hay and its value as a feedstuff for ruminants. Angus (n = 6), Hereford (n = 3), and Charolais (n = 3; total n = 12; 226 ± 19.3 kg) steers were stratified by breed and then randomly assigned into 3 treatment groups: 1) long stem hay; 2) chopped (approx. Fifteen cm) hay; and 3) chopped and then cubed hay. Steers were adapted to their respective diets for 14 d, after which they were placed in metabolism crates for 10 d and allowed ad-libitum access to diets and water. The first 3 of the 10 d were used for adaptation to the crates followed by 7 d of data collection. All data was analyzed using the GLM procedures in SAS. There was no difference ($P > 0.05$) for DM intake of the steers consuming the 3 diets (between 4.0 and 4.3 kg/d; 1.8 and 1.9% BW/d). Apparent digestibility of DM (between 61 and 71%, SEM = 3.3), organic matter (between 63 and 73%, SEM = 7.9), NDF (between 63 and 72%, SEM = 3.3), ADF (between 60 and 70%, SEM = 3.9), hemicellulose (between 66 and 75%, SEM = 2.8), and energy (63 and 71%, SEM = 3.2) were not different ($P > 0.05$) among the 3 diets. However, steers consuming long stem hay digested more ($P = 0.0302$) CP (65%, SEM = 5.6) than those consuming chopped hay (39%, SEM = 5.6) with those consuming cubed hay had an intermediate value (51%, SEM = 5.6). Additionally, Steers fed long stem and chopped hay (68 and 63%, respectively, SEM = 3.8) digested more ($P = 0.0071$) fat than those fed cubed hay (47%, SEM = 3.8). For hay producers that are interested in cubing hay for the fuel market, it appears that when prices for cubes used as fuel are reduced, selling cubed hay as a feed may be a viable alternative.

Key Words: cubed hay, digestibility, beef cattle

456 Effect of cutting time and conditioning method on cattle preference for trefoil-grass hay. R. Berthiaume^{*1}, A. F. Brito², and C. Lafreniere¹, ¹Agriculture & Agri-Food Canada, Sherbrooke, QC, Canada, ²University of New Hampshire, Durham.

Ruminants prefer forages cut in the afternoon. However, PM-cut could increase losses due to rainfall, prolonged wilting time, leaching and respiration. Maceration, an intensive mechanical conditioning applied to herbage, can enhance field drying, reduce wilting time and improve animal performance. We hypothesized that maceration would have different effects when applied to forages cut in PM vs. AM. A trefoil-grass field was divided in 4. Half was cut at 18:00(PM) with a mower conditioner. Fifty percent of the PM cut herbage was macerated after 12 h and left to wilt. The other half of the field was cut at 06:00 (AM) the next morning with 50% of the AM cut herbage macerated after 4 h and left to wilt. The 4 hays were field dried, baled at the same time, and chopped before their use. Two preference trials were conducted with the same 6 growing steers. The first trial was conducted in October 2008 whereas the second was conducted in February 2009. During adaptation, hays were offered alone as meals. In the experimental phase, every possible pair of hays (n = 6) was randomly presented for a meal to each of the 6 steers over 6 consecutive days. Dry matter intake was measured after 2, 4, 8, and 24 h. Data were analyzed by multidimensional scaling and by ANOVA with a model including hay and animal effects. During the first trial steers showed a preference for PM over AM-cut hay at every time points ($P = 0.006$). Steers ingested 222, 177, 133 and 38% more DM ($P \leq 0.0001$) from PM than AM-cut hay after 2, 4, 8 and 24 h. In the second trial steers showed no preference for PM over AM-cut hay (P

= 0.51). Nevertheless, DMI was 57, 60 and 51% higher ($P \leq 0.007$) for PM over AM-cut hay after 2, 4 and 8 h. DMI after 24h was not affected by cutting time. In both trials, there was no effect of maceration and no interaction between cutting time and maceration. Maceration had no effect on the preference of cattle for trefoil-grass hay whether it was cut in the PM or AM.

Key Words: feeding preferences, dry matter intake, conditioning

457 Acceptability of teff hay by horses. S. McCown^{*}, M. Brummer, J. Earing, S. Hayes, and L. Lawrence, *University of Kentucky, Lexington.*

Teff hay (*Eragrostis tef*) is a summer annual forage that has recently been introduced to the equine industry in the United States. Teff hay has been fed to horses in parts of the US; however, its relative acceptability compared with other hays has not been reported. Therefore, a study was conducted to evaluate the acceptability of 2 different teff hays when compared with midmaturity alfalfa (A) or timothy (TIM) hay. Two teff varieties were used: Horse Candi (HCT) and Tiffany (TT). The HCT was planted June 8, 2009, and harvested August 16, 2009, in the late heading stage. The TT was planted June 2, 2008, and harvested on July 11, 2008, in the early heading stage. The acceptability of both types of teff was compared with A in experiment 1 (E1) and to TIM in experiment 2 (E2) using 2-choice preference tests. Each experiment used 4 mature mares that had been previously acclimated to individual 3 × 15 m partially covered pens. Mares were offered a different combination of 2 hays each day, so each mare received all combinations in the experiment. The 2 hays were offered in side-by-side hay nets in the pens for 2, 1 h periods on 3 consecutive days. In the first period, 4 kg of each hay was offered to the mares. After an hour, the hay nets were taken away for 1 h. The mares were then offered new hay nets for 1 h with the same hay combination, but with the right-left positions reversed. Hay nets were weighed to determine intake of each hay. In E1, mares consumed more A than HCT (1.66 kg A vs 0.24 kg HCT; $P < 0.05$; SE = 0.25), more A than TT (1.74 kg A vs 0.16 kg TT; $P < 0.05$; SE = 0.25), and more TT than HCT (1.08 kg TT vs 0.24 kg HCT; $P < 0.05$; SE = 0.25). In E2, mares consumed more TIM than HCT (1.54 kg TIM vs 0.12 kg HCT; $P < 0.05$; SE = 0.16), more TIM than TT (1.04 TIM vs 0.66 kg TT; $P < 0.05$; SE = 0.16), and more TT than HCT (0.65 kg of TT vs 0.33 kg HCT; $P < 0.05$; SE = 0.16). When given a choice, mares chose A and TIM over either variety of teff. The mares did discriminate between the 2 teff hays. The reason for the difference in preference between TT and HCT has yet to be determined.

Key Words: preference, horse, hay

458 Nutritive value of North American grasses during establishment. A. E. Lee^{*1,4}, J. P. Muir³, B. D. Lambert^{1,3}, J. L. Reilley², and T. R. Whitney⁴, ¹Tarleton State Univ., Stephenville, TX, ²Kika de La Garza PMC, Kingsville, TX, ³TX AgriLife Research, Stephenville, ⁴TX AgriLife Research, San Angelo.

Non-native grass species currently used by ranchers can become invasive. To promote the use of native warm-season grasses as forage, more nutritive information is needed. In the spring of 2007 (establishment year), seeds from 3 native grasses [plains bristlegrass (*Setaria vulpiseta* Scribn. and Merr., PBG); multiflower false rhodesgrass (*Chloris pluriflora* Fourn., MFR); and pink pappusgrass (*Pappophorum bicolor* Fourn., PPG)] were collected in south Texas. Plants were then grown in a greenhouse and transplanted into plots (n = 1 to 2/species) within block (n = 4) located in Stephenville, TX, with either no fertilizer or a single spring application of N (67 kg/ha) and P (127 kg/ha) fertil-

izer. During July to November (2007) and April to November (2008), monthly clippings were taken to evaluate effects of fertilization on forage N, NDF, and ADF and in vitro organic matter digestibility (IVOMD) using fistulated steers and goats. During both years, a species \times treatment \times month interaction ($P < 0.10$) was observed for N. During year 1, N in PBG increased ($P = 0.04$) in September due to fertilization, but average species N increased ($P = 0.02$) due to fertilization in July and September. During year 2, N in PBG increased in July, but unexpectedly decreased in October ($P < 0.04$) due to fertilization. No species \times month interaction ($P = 0.19$) was observed for NDF during year 1, but was observed ($P < 0.001$) during year 2. A species \times month interaction ($P < 0.001$) was observed for ADF during both years. An animal \times species \times month interaction ($P < 0.001$) was observed for IVOMD for both years. The IVOMD determined using rumen fluid from goats was greater ($P < 0.02$) for all species during July, October, and November of year 1 and greater ($P < 0.05$) for MFR and PPB during April and May of year 2. Differences in nutrient characteristics and digestibility need to be considered when utilizing these grass species.

Key Words: fiber, native grasses, digestibility

459 Effects of different manure sources and urea on chemical composition of three tropical pasture grasses. O. M. Arigbede^{1,2}, U. Y. Anele^{1,2}, K.-H. Südekum², J. A. Olanite¹, A. O. Oni¹, P. A. Dele¹, and J. O. Bolaji¹, ¹University of Agriculture, Abeokuta, Nigeria, ²University of Bonn, Bonn, Germany.

A study was carried out to investigate the effects of different fertilizer types on chemical composition of 3 tropical grasses. The grasses were established in the small ruminant paddocks on the teaching and research farm, University of Agriculture, Abeokuta, Nigeria. The grasses were cut at 10 cm above ground level and sampled 4 weeks before the commencement of the trial and subsequently on monthly basis. A 4 \times 3 factorial design was adopted with 4 treatments (control - no manure, urea - 150 kg/ha, caged layers droppings - 250 kg/ha, compost manure - 350 kg/ha) and 3 grass species (*Panicum maximum* (local), *P. maximum* (Ntchisi), and *Pennisetum purpureum*) with 3 field replicates. About 1 kg of each grass species from every plot were cut at 10 cm above ground level, weighed, and oven-dried at 65°C to a constant weight. The plots were maintained weed-free through manual weeding. Manure application generally improved ($P < 0.05$) the chemical composition of the grasses when compared with the urea fertilized and unfertilized ones. Differences ($P < 0.05$) existed between the major nutrient contents with the grasses fertilised with caged layer droppings recording the highest CP concentration (161, 168, and 150 g/kg DM) and the lowest NDF (ash-free) concentration (388, 363, and 448 g/kg DM) for *P. maximum* (local), *P. maximum* (Ntchisi), and *P. purpureum*, respectively. The nutrient contents of the 3 grasses did not differ ($P > 0.05$) between grasses fertilized with caged layer droppings or compost manure. There was also no difference ($P > 0.05$) in the ash content of grasses from the 4 treatments. The use of organic manure proved more effective in enhancing the chemical composition of tropical pasture grasses when compared with those under urea fertilization. Therefore, based on this study organic manure is recommended as a tool for organic ruminant livestock production grazing systems.

Key Words: tropical grass, chemical composition, fertilizer

460 In vitro ruminal fermentation characteristics of anthocyanidin accumulating Lc-alfalfa. A. Jonker^{1,2}, M. Gruber², Y. Wang³, and P. Yu¹, ¹Department of Animal and Poultry Science, College of Agriculture and Bioresources, University of Saskatchewan, Saskatoon,

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Transformed Lc-progeny were previously found to have a decrease initial rate of N and DM degradation but did not survive winter conditions in western Canada. Therefore, the objective of this study was to determine the effect of winter hardy Lc-progeny expressing different phenotypes on in vitro fermentation characteristics. To develop winter hardy Lc-progeny, 3 non-winter hardy transgenic T0 Lc-alfalfa populations 88-19, 88-09 and 88-01 were crossed with 3 winter hardy alfalfa varieties Rangelander, Rambler and Beaver, respectively and harvested at a vegetative pre-bud stage. The Lc-plants were subsequently phenotyped into 3 groups per population in the field based on colors, green (Gr), light purple-green (LP) and purple-green (PG). Ground (1 mm) freeze-dried samples were compared in quad duplicate for their ruminal fermentation characteristics with their non-transgenic (NT) parents using a in vitro gas production technique. The results were analyzed in a completely randomized design with repeated measurement in Proc Mixed of SAS. Anthocyanidin concentration was 0, 103.9, 108.4 and 282.5 $\mu\text{g/g}$ DM in NT, Lc-Gr, Lc-LP and Lc-PG alfalfa, respectively. The NT-alfalfa had the highest ($P < 0.05$) and Lc-Gr alfalfa the lowest ($P < 0.05$) cumulative gas production after 48 h. Average gas production per h, fractional degradation rate (K_d) and half time to maximum gas production were all higher ($P < 0.05$) in NT-alfalfa compared with the 3 Lc-alfalfa phenotypes. At 48-h incubation, concentration of methane in total gas was lower ($P < 0.05$) and concentration of propionic acid was higher ($P < 0.05$) in Lc-LP alfalfa compared with NT-alfalfa, whereas production of total volatile fatty acids (VFA) was similar between Lc-LP and NT-alfalfa. It was also observed that branch chain VFA concentration was higher ($P < 0.05$) and NH_3 concentration lower ($P < 0.05$) for the 3 Lc-phenotypes compared with NT-alfalfa after 48-h incubation. In conclusion, all 3 Lc-alfalfa phenotypes accumulated anthocyanidin and fermentation profiles differed between the 3 phenotypes and between non-transgenic alfalfa and Lc-alfalfa.

Key Words: anthocyanidin-accumulating alfalfa, in vitro ruminal fermentation, methane

461 Revisiting heat damaged-protein and ruminal degradation kinetics in heated hays. W. K. Coblenz¹, P. C. Hoffman², and N. P. Martin³, ¹US Dairy Forage Research Center, Marshfield, WI, ²University of Wisconsin, Madison, ³US Dairy Forage Research Center, Madison, WI.

Previous studies utilizing conventional (45-kg) hay bales have shown that acid-detergent insoluble CP (ADICP), ruminal CP degradation rate (K_d), and rumen degradable protein (RDP) are related to various measures of spontaneous heating in simple linear relationships that frequently exhibit relatively high r^2 statistics. However, large-round bales often attain much greater maximum internal bale temperatures (MAX) during storage than conventional 45-kg bales, and these greater temperatures may persist for longer durations of time. Our objective was to use regression techniques to relate ADICP, K_d , and RDP to spontaneous heating within large-round bales of mixed alfalfa-orchardgrass hay, and then to compare these responses to the simple linear relationships observed commonly within conventional 45-kg bale packages. Changes in concentrations of ADICP (poststorage - prestorage; ΔADICP) during storage increased with heating degree days $>30^\circ\text{C}$ (HDD), and were best explained with a nonlinear model [$Y = 14.9 - (15.7 * (e^{-0.0000019 * x}))$]; $R^2 = 0.934$]. A similar quartic response ($Y = -0.000053x^4 + 0.012x^3 - 1.00x^2 + 35.7x - 470.9$; $R^2 = 0.975$) was observed for the regression of ΔADICP on MAX. Changes in K_d during storage (ΔK_d) were best explained with

cubic models for regressions on both HDD ($R^2 = 0.939$) and MAX ($R^2 = 0.876$), and these changes represented an approximate 50% rate reduction in severely heated hays relative to prestorage controls. Within ranges of heating most commonly encountered under field conditions, changes in RDP during storage (ΔRDP) declined in mostly linear relationships with HDD or MAX. However, when severely heated hays also were considered, the relationships became cubic ($Y = -0.0000000079x^3 + 0.000028x^2 - 0.027x + 1.1$; $R^2 = 0.802$) for HDD and quadratic ($Y = 0.025x^2 - 3.04x + 86.5$; $R^2 = 0.734$) for MAX. Generally, responses for ADICP, K_d , and RDP in large-round bales were consistent with the linear nature observed previously within conventional 45-kg bales at low-to-modest increments of heating, but exhibited more complex relationships when heating became more extreme.

Key Words: spontaneous heating, ADICP, ruminal kinetics

462 Effects of spontaneous heating on estimates of energy from alfalfa-orchardgrass hays stored in large-round bales. W. K. Coblenz*¹ and P. C. Hoffman², ¹US Dairy Forage Research Center, Marshfield, WI, ²University of Wisconsin, Madison.

Using the summative approach to estimate total digestible nutrients (TDN), truly digestible fiber can be estimated from inputs of: i) protein-corrected NDF and acid-detergent lignin (LIG-METHOD); or ii) protein-corrected NDF and 48-h neutral detergent fiber digestibility (NDFD-METHOD). Our objectives were to assess the relationship between TDN and spontaneous heating, and to describe any differ-

ences that may result specifically from the 2 methods of estimating truly digestible fiber. During 2006 and 2007, mixed alfalfa (*Medicago sativa* L.)-orchardgrass (*Dactylis glomerata* L.) hays were obtained from 3 harvests at the same 8.2-ha research site. Following storage of the hays, both options for estimating truly digestible fiber (LIG-METHOD or NDFD-METHOD) were then used via the summative approach to estimate the total concentrations of TDN (TDN-LIG or TDN-NDFD, respectively). Estimates of both TDN-LIG and TDN-NDFD were related to heating degree days $>30^\circ\text{C}$ accumulated during storage by various regression techniques. Changes (poststorage – prestorage) in TDN-LIG that occurred during storage ($\Delta\text{TDN-LIG}$) were best fitted with a non-linear decay model in which the independent variable was squared [$Y = (11.7 * e^{-0.000033*x*x}) - 11.6$; $R^2 = 0.928$]. For changes in TDN-NDFD ($\Delta\text{TDN-NDFD}$), a quadratic regression model provided the best fit ($Y = 0.000027x^2 - 0.010x + 0.4$; $R^2 = 0.861$). Generally, $\Delta\text{TDN-LIG}$ was 2.0 to 4.0 percentage units lower (more negative) than $\Delta\text{TDN-NDFD}$ when heating degree days $>30^\circ\text{C}$ exceeded 500. For regressions on maximum internal bale temperature, both $\Delta\text{TDN-LIG}$ ($Y = -0.38x + 16.3$; $r^2 = 0.954$) and $\Delta\text{TDN-NDFD}$ ($Y = -0.25x + 10.2$; $r^2 = 0.848$) were best fitted by linear models with heterogeneous ($P < 0.001$) slopes and intercepts. In general, TDN-NDFD was greater in heated hays than TDN-LIG, largely because the relationship between NDFD and spontaneous heating was poor. In contrast, TDN-LIG declined more rapidly with spontaneous heating, largely because the LIG-METHOD for estimating truly digestible fiber was sensitive to changes in concentrations of both protein-corrected NDF and acid-detergent lignin.

Key Words: alfalfa hay, spontaneous heating, TDN