411 Impacts of feeding a citrus extract on measures of heat stress, as well as production, of high producing dairy cows during summer heat. J. M. Soderstrom*[1], P. H. Robinson[1], and J. M. Clauzel[2], *[1]Department of Animal Science, University of California-Davis, Davis, [2]Phodé Laboratoires, Terssac, France.*

High somatic cell counts (SCC) in milk result from degraded mammary health and negatively affect animal performance and milk quality. Citrus by-products are high in antioxidants (i.e., vitamin C) and essential oils (e.g., limonene), both of which have positive effects on animal health. We determined effects of feeding an orange extract (OE) to high producing dairy cows on measures of heat stress as well as milk production and composition, including SCC. A replicated 2 × 2 Latin square experiment was conducted with two 28-d periods on a dairy farm near Hanford (CA) in summer 2011 with 4 high group pens (i.e., cows which had cleared the fresh pen but not yet confirmed pregnant), each with ~310 early lactation multiparity cows. Total mixed rations (TMR; based on alfalfa hay, almond hulls, canola meal, distillers dried grains with solubles, corn silage, corn grain and cottonseed, with 17% crude protein (CP), 5.4% fat, 33.4% neutral detergent fiber (NDF) and 13.4% starch were identical except for inclusion of orange extract (Veo Premium, Phodé, Terssac, France) at 4 g/cow/d in the treatment TMR (OE). Due to seasonally mild ambient temperatures (i.e., highs 31–34°C; lows 16–17°C), cows showed only mild heat stress. Feeding OE had no effect on indicators of heat stress (i.e., respiration rate, panting score, rump temperature) at anytime (i.e., 02:45, 09:15, 17:30). However at 02:45 h, a higher ($P < 0.01$) proportion of OE cows were lying (vs. standing) vs. control cows (68.6 vs. 53.7%), a possible indicator of reduced heat stress. DM intake (avg. 25.3 kg/d) and whole tract digestibility of organic matter (71.9%), CP (70.3%) and NDF (51%) did not differ between treatments. Milk production (avg. 47.3 kg/d) and composition (avg. 3.54, 2.86, 4.78% fat, true protein, lactose) also did not differ, and changes in body condition and locomotion score were not affected. However, SCC for OE cows was lower ($P < 0.05$) than control (160,000 vs. 196,000). Feeding this OE to high producing California cows during moderately hot summer weather decreased SCC with no effect on other aspects of performance or indicators of heat stress.

Key Words: limonene, vitamin C, SCC

412 Meta-analysis of the effects of dietary sugar on intake and productivity of dairy cattle. C. F. Vargas*[1], C. D. Reinhardt[1], J. L. Firkins[2], and B. J. Bradford[1], *[1]Kansas State University, Manhattan, [2]Ohio State University, Columbus.*

A meta-analysis was performed to determine the possible effects of dietary sugar on feed intake and milk production in lactating dairy cattle. The database used in this analysis included 18 treatment comparisons from 10 studies reported between 1985 and 2011. Treatment comparisons were used only if 1) either sucrose (n = 9) or molasses (n = 9) replaced corn grain without adding fat, and 2) sugar added by treatment ranged from 2 to 5% of DM. In addition, 1 study was excluded because the SD for DMI response was more than twice the mean SD across studies. The meta-analysis included studies analyzed by both fixed effects and mixed effects statistical models. To account for the differences in SEM reported for treatment means by these approaches, studies with repeated measures that used a mixed effects model were re-analyzed to estimate fixed effects model SEM; this approach allowed for consistent weighting across studies. The meta-analysis was conducted using a random effects model. First, responses to sucrose and molasses were compared using Cochran's Q statistic, and no evidence for heterogeneity across sugar sources was found in either DMI ($P = 0.25$) or ECM ($P = 0.59$) responses. Therefore, different sugar sources were pooled for the remaining analyses. In the final data set, ECM and DMI responses to added sugar were moderately correlated (r = 0.68, $P < 0.001$). No evidence of publication bias was observed for DMI, although for ECM, the trim and fill method suggested that 2 additional studies with negative responses would be required to generate a normal response distribution. The combined data included in this analysis showed that the addition of sugar tended ($P = 0.07$) to increase DMI by 0.38 kg/d (95% confidence interval: −0.04 to +0.80 kg/d). On the other hand, no effect was detected for ECM ($P = 0.34$; 95% confidence interval: −0.29 to +0.85 kg/d). In summary, results of this analysis suggest that the addition of 2 to 5% dietary sugar may promote small increases in DMI, but do not consistently increase ECM in lactating dairy cattle.

Key Words: lactation, molasses, sucrose

413 Potential use of specific milk fatty acids to predict enteric methane emissions from lactating dairy cows. K. E. DeLand,* M. Hollmann, J. C. Ploetz, W. J. Powers, D. K. Beede, and A. L. Lock, *Michigan State University, East Lansing.*

The ability to accurately predict methane emissions is valuable for the quantitative monitoring of environmental and management impacts of livestock production. Biomarkers such as milk fatty acids (FA) may be a useful tool for the prediction of enteric methane emissions from lactating dairy cows. This study assessed if there was a relationship between the concentration or yield of specific milk FA and enteric methane emissions. Methane emissions (by gas flux in environmentally controlled rooms) and lactation performance were measured from individual lactating Holstein cows fed a TMR with 0.0% (control), 1.3, 2.7, or 3.3% coconut oil, DM basis. Compared with control, daily methane emissions declined 3.2, 37.3, and 45.5% with increased coconut oil, respectively. Milk samples were obtained from 4 milkings (d 26 and 28 of the 35-d experiment). We evaluated the relationship between the concentration (g/100 g FA) and yield (g/milking) of individual milk FA and methane emissions for the 24-h period preceding each milking. Multiple regression analysis using forward selection criteria identified significant FA that predicted methane emissions. On a FA concentration basis, the overall coefficient of determination (CD) for methane output ($R^2 = 0.86$, $P < 0.05$) was due primarily to C18:1 12*c* ($R^2 = 0.78$, $P < 0.0001$), C18:1 9*t* ($R^2 = 0.05$, $P < 0.001$), and C16:1 *iso* ($R^2 = 0.03$, $P < 0.01$). On a FA yield basis, the overall CD for methane output ($R^2 = 0.90$, $P < 0.05$) was due primarily to C13:0 *iso* ($R^2 = 0.65$, $P < 0.0001$), C18:1 12*c* ($R^2 = 0.07$, $P < 0.01$), C15:0 *iso* ($R^2 = 0.07$, $P < 0.001$), C18:1 9*t* ($R^2 = 0.05$, $P < 0.001$), and C20:5 ($R^2 = 0.02$, $P < 0.05$). Concentration of C18:2 12*c* and yield of C13:0 *iso* also were important in explaining 12-, 36-, and 48-h methane emissions, with similar CD as found for 24-h methane emissions. Results confirm a positive relationship between enteric methane emissions and C15:0 *iso*. Importantly, results suggest for the first time that C18:1 12*c* and C13:0 *iso* may be important milk FA for prediction of enteric methane emissions in lactating dairy cows.

Key Words: dairy cows, methane emissions, milk fatty acids

414 Nitrogen concentration and source alter products from fermentation of glucose by mixed ruminal microbes. M. B. Hall,* *U.S. Dairy Forage Research Center, USDA-ARS, Madison, WI.*

Effects of N source and concentration on microbial fermentation products formed over time were evaluated. Replicated in vitro fermentations with mixed ruminal microbes were performed with 3 treatments (Ntrt): LoN (Goering and Van Soest media with 12% less N by removal of enzymic digest of casein; 0.337 g N/L), and HiNU (urea added) and HiNT (enzymic digest of casein added) both with 0.385 g N/L. Glucose (Glc) at 3 g/L was the carbohydrate substrate. Fermentation vessels were destructively sampled at 0, 0.25, 0.5, 0.75, 1, 2, and 3 h of fermentation. Data were analyzed as a randomized complete block design with the factors Ntrt, hour of fermentation (HR), the interaction, and fermentation run (random variable) in the model. Disappearance of Glc did not differ by Ntrt (Ntrt: $P = 0.92$; Ntrt x HR: $P = 0.85$) with residual Glc at < 6% of initial Glc by 2 h. Microbial N accumulation (indicative of microbial growth) differed by Ntrt x HR ($P = 0.05$) with LoN smaller than HiNU and HiNT at 2 h (2.19, 2.52, and 2.48 mg N, respectively), and LoN and HiNT greater than HiNU at 3 h (2.80, 2.69, and 2.48 g N, respectively; SED: 0.136). Microbial glycogen peaked at 2 h, then declined. Maximum glycogen mg detected were LoN:11.0, HiNU:10.7, and HiNT:10.1 (SED = 0.108; $P = 0.03$) with HiNT differing from HiNU and LoN ($P < 0.04$). Organic acid production differed among Ntrt at 0.25 and 0.5 h; mean organic acid concentrations for these 2 time points showed LoN and HiNU greater than HiNT (4.42, 4.25, and 2.83 mM, respectively; SED = 0.254; Ntrt: $P = 0.02$, Ntrt x HR: $P = 0.10$). Molar percentages of acetate, propionate, and butyrate did not differ for Ntrt or Ntrt x HR in this same time span ($P > 0.20$), however, yield of carbon in organic acids per Glc carbon that disappeared from the media differed for Ntrt ($P = 0.01$; SED = 0.004) and Ntrt x HR ($P < 0.01$; SED = 0.005) with least squares means values averaging 0.083, 0.085, and 0.062 for LoN, HiNU, and HiNT, respectively. Ntrt did not differ in maximal lactate concentrations ($P = 0.99$; LoN: 1.28, HiNU: 1.28; HiNT: 1.36 mM; SED = 0.709). The effect of N source and amount on microbial products may have implications as factors that could alter nutrient supply to the cow.

Key Words: nonfiber carbohydrate, protein, rumen fermentation

415 Interactions in rumen pool characteristics by dairy cows fed two concentrations of a novel co-product from corn wet milling with different forage sources. D. M. Shepherd*[1], J. L. Firkins[1], and P. von Behren[2], *[1]Department of Animal Sciences, The Ohio State University, Columbus, [2]Cargill Corn Milling, Blaire, NE.*

Increasing particle length or decreasing fragility should increase the density of the rumen mat, rumination time, and the retention time of particles in the rumen in part by trapping smaller particles. We used a novel corn wet milling co-product, termed Dairy Protein Product (DPP, coarse particle size and approximately 70% DM, 27.1% CP, 27.5% NDF, and 23.9% NSC) in diets formulated to contain 19.0% forage NDF, 17.4% CP, 20.2% starch, and 3.7% sugar. Six primiparous, rumen-cannulated Jersey cows were assigned to a 6x6 Latin square design with a 2 × 3 factorial arrangement of treatments in 6 periods of 3 wk (last week for data collection). We hypothesized for an interaction between 20 and 30% DPP with forage source (corn silage, CS, 46% NDF; CS replaced with 10% alfalfa hay, AH, 45% NDF; or CS with 7% grass hay, GH, 63% NDF). We expected that forage source would have minimal effect on production or rumen mat characteristics (from 2 rumen evacuations) when DPP was included at 20% of dietary DM, but when DPP was increased to 30%, we expected that CS+ AH would increase rumen mat consistency and associated ruminal fluid weight more than would CS alone but potentially less than CS+GH. Means were compared by pre-planned contrasts. There were no effects on production of milk or milk components, but DMI tended ($P = 0.10$) to increase when 20% DPP was included with CS and with reciprocal effects on fat-corrected milk/DMI. For CS only, DMI (16.1 vs. 14.8 kg/d) decreased ($P < 0.05$) when DPP was increased from 20 to 30% DPP; in contrast, rumen DM pool increased ($P < 0.05$) from 8.04 to 8.65 kg/d. Grass hay increased ($P < 0.05$) total and liquid pool size of rumen contents compared with AH (by 3.2 and 3.0 kg). No effects of ruminal pH were noted (averaging 5.99). In diets containing low starch (with 4% corn grain), increasing DPP from 20 to 30% requires more attention to interactions among forages with respect to fill, digestion, and passage of fiber.

Key Words: corn co-product, forage source, rumen pool

416 Fates of medium-chain fatty acids fed to lactating dairy cows. M. Hollmann*[1], M. S. Allen[1], T. H. Herdt[2,3], J. S. Zyskowski[3], K. M. Lebbin[1], J. P. Steibel[1], and D. K. Beede[1], *[1]Department of Animal Science, Michigan State University, East Lansing, [2]Department of Large Animal Clinical Sciences, Michigan State University, East Lansing, [3]Diagnostic Center for Population and Animal Health, Michigan State University, East Lansing.*

We examined fates of dietary saturated medium-chain fatty acids (FA; C8 through C14). Eight lactating Holstein cows were fed a TMR with either coconut oil (CNO) or Energy Booster (EB) supplemented at 3.35% of diet DM for 28 d in a crossover design. Concentrations of FA in rations were 0.6 or 0.0% C8:0, 1.8 or 0.1% C10:0, 13.9 or 0.3% C12:0, and 6.8 or 1.4% C14:0, for CNO or EB, respectively (total FA basis). Cows were fed ad libitum once daily at 1000 h. Rumens were evacuated and contents sampled 4 h post-feeding (d 26) and 2 h pre-feeding (d 28). Blood samples were obtained (d 17 to 20) before feeding and hourly post-feeding for 6 h. Data were analyzed by ANOVA with repeated measures. CNO reduced DMI 17% ($P < 0.001$), but did not affect weight or volume of ruminal contents. CNO resulted in reduced total FA concentration in ruminal contents, increased plasma concentration of total FA, and depressed milk fat yield (d 22 to 25) compared with EB ($P < 0.01$). CNO vs. EB increased ruminal concentrations of C8:0 and C10:0 post-feeding ($P < 0.001$), but not pre-feeding. Although apparent total tract digestibilities of these FA were nearly complete (>98%), their respective yields in milk were reduced ($P < 0.001$) and plasma concentrations were minute in CNO-fed cows. Amounts of C12:0 and C14:0 in rumen contents were greater with CNO than with EB ($P < 0.01$). Ruminal turnover rates per h were > 100% for C8, 58% for C10, 5.8% for C12, and 4.8% for C14 in CNO-fed cows. CNO increased C12:0 and C14:0 concentrations in plasma and in milk fat compared with EB. Yet, milk fat yield of C14 decreased with CNO. Apparent transfer from diet (CNO) to milk was 57% for C12 and 187% for C14. Disappearance of C8 and C10 (not accounted for in ruminal contents, plasma, feces, or milk) suggests rapid absorption and oxidation. Ruminal turnover rate and apparent total tract digestibilities of FA decreased with increased chain length from C8 to C14. Increased conversion of C14 vs. C12 into milk FA and greater increase of C14 vs. C12 in plasma FA indicate reduced uptake of C14 by extra-mammary tissue. Results suggest large differences in fate among medium-chain FA fed to lactating cows.

Key Words: β-oxidation, digestibility, partitioning

417 The effect of rumen digesta inoculation on the time course of recovery from diet induced milk fat depression in dairy cows. D. E. Rico,* Y. Ying, A. R. Clarke, and K. J. Harvatine, *Penn State University, University Park.*

The predominant pathway and rate of ruminal biohydrogenation is dependent on the rumen environment and microbial population. Ten ruminally cannulated cows were used in a crossover design that investigated the effect of rumen digesta inoculation from non-milk fat depressed cows on recovery from diet induced milk fat depression. Two additional cows fed a control diet (32% NDF, no supplemental PUFA) were used as rumen digesta donors. MFD was induced from d 1 to 10 of each period by a low fiber and high oil diet (27% NDF and 3.0% soybean oil). On d 11 all cows were switched to the control diet treatment (trt) was no inoculation and ruminal inoculation (Inoc) with 8 kg of donor cow digesta/d from d 11 to 16. Milk yield and composition were measured every 3 d from d 10 to 28. Data were analyzed using repeated measures. The model included period, sequence, and cow nested in sequence as random effects and trt, d on diet, trt × d, and a covariate (d10 value) as fixed effects. Day was the repeated variable and cow × period was the subject. Second, a random regression model that included the random effect of cow and period, and the fixed effect of trt and trt × d, and trt × d^2 interactions were used for analysis of the rate of recovery. Both milk fat concentration and yield increased progressively during the recovery phase and trt were not different at any time points. However, in the regression analysis, there was an effect of trt and trt × d and trt × d^2 interactions for fat concentration and an effect of trt and a trt × d interaction for fat yield (All $P < 0.01$). The best fit predictions for milk fat concentration for the Con and Inoc were $1.55 + 0.161 \times d + (-0.003) \times d^2$ and $0.56 + 0.253 \times d + (-0.005) \times d^2$, respectively. The concentration of milk fatty acids less than 16 carbons increased progressively in both trt and was higher for Inoc than Con on d 16. In contrast, milk fat concentration of *trans*-10 C18:1 and *trans*-11 C18:1 decreased progressively and was not affected by trt. Under the conditions of the current experiment, ruminal inoculation from non-milk fat depressed cows modestly accelerated the rate of recovery from diet induced milk fat depression.

Key Words: milk fat depression, biohydrogenation, CLA

418 Effect of carbohydrate conformation in hulless barley *(Hordeum vulgare* L.) on in situ rumen and in vitro intestinal nutrient availability. L. Yang*[1,3], J. McKinnon[1,3], D. Christensen[1,3], B. Rossnagel[2,3], A. Beattie[2,3], and P. Yu[1,3], *[1]Department of Animal and Poultry Science, [2]Crop Development Centre, [3]University of Saskatchewan, Saskatoon, SK, Canada.*

Hulless barley breeding lines varying in amylose (1 to 20% DM), amylopectin (34 to 51% DM), amylose to amylopectin ratio (Ay:Ap) (0.02 to 0.59) and β-glucan content (5 to 10% DM) have been developed at the Crop Development Centre, University of Saskatchewan. The objective of this study was to determine the effect of these new hulless barley lines (zero-amylose waxy, CDC Fibar; 5%-amylose waxy, CDC Rattan; normal-amylose, CDC McGwire and high-amylose, HB08302) on rumen degradation kinetics and in vitro intestinal nutrient digestion (CDC Copeland was included as a hulled control). Three dry Holstein cows fitted with rumen cannula were used for measuring rumen degradation of barley varieties. The estimation of intestinal digestion was determined by a modification of the 3-step in vitro procedure described by Calsamiglia and Stern with duplicate of each in situ residue. Among the hulless barley lines, HB08302 was greater ($P < 0.05$) in rumen bypass dry matter (BDM: 46.5 vs. 33.4% DM), rumen bypass starch (BST: 40.3 vs. 25.2% ST or 218 vs. 155g/kg DM) and reduced ($P < 0.05$) in effective degradability of dry matter (EDDM: 53.5 vs. 66.6% DM) and starch (EDST: 59.8 vs. 74.8% ST or 320 vs. 461 g/kg DM) compared with CDC Rattan. HB08302 was also greater ($P < 0.05$) in rumen bypass crude protein (BCP: 52.1% CP), effective degradability of neutral detergent fiber (EDNDF: 74 g/kg DM) and intestinal absorbable feed protein (IADP: 40.6% CP) but reduced ($P < 0.05$) in total digestible protein (TDP: 120 g/kg DM) than the other hulless barley lines. CDC Fibar showed greater ($P < 0.05$) effective degradability of crude protein (EDCP: 90 g/kg DM) while CDC McGwire showed reduced ($P < 0.05$) TDP (116 g/kg DM). Compared with hulless barley, the hulled CDC Copeland showed relatively greater ($P < 0.05$) BNDF (62.5% NDF or 98 g/kg DM), starch degradation rate (K_d: 17.4%/h) and EDST (75.9% ST) but reduced ($P < 0.05$) BCP (49 g/kg DM), rumen undegradable protein (RUP: 55 g/kg DM) and TDP (102 g/kg DM). In conclusion, hulless barley lines with altered carbohydrate traits have the potential to increase rumen and intestinal nutrient availability to ruminants.

Key Words: amylose to amylopectin ratio, hulless barley, rumen degradation and intestinal digestion

419 Palmitic acid increased milk yield and feed efficiency across production level of lactating cows. P. Piantoni,* A. L. Lock, and M. S. Allen, *Michigan State University, East Lansing.*

The objective of this experiment was to evaluate the effects of palmitic acid supplementation on feed intake, digestibility, and metabolic and production responses of dairy cows with a wide range of milk production (35 to 66 kg/d) in a crossover design experiment with a covariate period. Thirty-two multiparous Holstein cows (151 ± 66 DIM) were assigned randomly within level of milk yield to treatment sequence. Treatments were diets supplemented (2% of diet DM) with palmitic acid (PALM, 99% C16:0) or control (CONT, soy hulls). Treatment periods were 21 d with the final 4 d used for data and sample collection. No interactions were detected between treatment and milk yield when all cows received a common diet during the covariate period for any response variable. Compared with CONT, the PALM treatment increased milk yield (46.0 vs. 44.9 kg/d, $P = 0.04$), milk fat concentration (3.4 vs. 3.3%, $P = 0.01$) and yield (1.53 vs. 1.45 kg/d, $P = 0.001$), and 3.5% fat-corrected milk (FCM, 44.63 vs. 42.89 kg/d, $P < 0.01$). Treatment did not affect dry matter intake (DMI, $P = 0.96$), yield and concentration of protein and lactose in milk ($P > 0.12$), or body weight ($P = 0.58$). The PALM treatment increased feed efficiency (3.5% FCM/DMI, 1.61 vs. 1.55, $P < 0.0001$) and tended to decrease body condition score (2.93 vs. 2.99, $P = 0.06$) compared with CONT. Compared with CONT, the PALM treatment increased total tract digestibility of NDF (38.7 vs. 35.4%, $P < 0.001$) and OM (67.3 vs. 66.0%, $P < 0.01$). The PALM treatment increased plasma concentration of NEFA (101.4 vs. 90.0 μEq/l, $P < 0.0001$) and the ratio of insulin to glucagon (0.092 vs. 0.083, $P = 0.05$), and tended to increase plasma concentration of insulin (11.4 vs. 10.3 μIU/ml, $P = 0.07$). Results show that palmitic acid has the potential to increase yields of milk and milk fat as well as the conversion of feed to milk, independent of production level without increasing body condition score or body weight.

Key Words: feed efficiency, milk fat, palmitic acid

420 Palmitic acid increased the yield of milk fat and improved feed efficiency across production level of cows compared with stearic acid. J. E. Rico,* M. S. Allen, and A. L. Lock, *Michigan State University, East Lansing.*

The effects of dietary palmitic (C16:0) and stearic (C18:0) acids on feed intake, yield of milk and milk components, and feed efficiency of

dairy cows with a wide range of milk production were evaluated in an experiment with a crossover arrangement of treatments and a covariate period. A wide range of milk production (38 to 65 kg/d) was used to determine if response to fat supplementation varied according to production level. Thirty-two Holstein cows (143 ± 61 DIM) were assigned randomly to treatment sequence within level of milk yield. Treatments were diets supplemented (2% of diet DM) with palmitic acid (PA; 99% C16:0) or stearic acid (SA; 98% C18:0). Treatment periods were 21 d with the final 4 d used for sample and data collection. The corn silage and alfalfa haylage based diets were formulated to contain 29% NDF, 17% CP, and 5.7% crude fat. The statistical model included the random effect of cow and the fixed effect of treatment and period. No interactions were detected between treatment and level of milk production when all cows received a common diet during the covariate period for any response variable. Compared with SA, the PA treatment increased milk fat concentration (3.55 vs. 3.66%, $P < 0.01$) and yield (1.59 vs. 1.68 kg/d, $P < 0.001$), and 3.5% fat-corrected milk yield (45.56 vs. 47.46 kg/d, $P < 0.001$). Treatment did not affect DMI, milk yield, milk protein yield, body weight, or body condition score (all $P > 0.10$). Milk protein concentration was lower for PA compared with SA treatment (3.24 vs. 3.29%, $P < 0.01$). The PA treatment increased feed efficiency (3.5% fat-corrected milk yield/DMI) compared with SA (1.48 vs. 1.40, $P < 0.001$). Results demonstrate that palmitic acid is more effective than stearic acid in improving milk fat concentration and yield as well as efficiency of feed conversion to milk. Responses were independent of production level and without change in body condition score or body weight. Further studies are required to test the consistency of these responses across different types of diets.

Key Words: milk fat, palmitic acid, stearic acid

421 Linseed oil reduces methane emissions from grazing dairy cows. T. M. Boland*[1], K. M. Pierce[1], J. D. Rowntree[1], D. A. Kenny[2], and A. K. Kelly[1], *[1]University College Dublin, Lyons Research Farm, Newcastle, Co. Dublin, Ireland, [2]Animal Bioscience Centre, Teagasc, Grange, Dunsany, Co. Meath, Ireland.*

Enteric methane accounts for approximately 50% of the total greenhouse gas emissions from the average Irish dairy farm as well as representing an energy loss to the animal. Lipid supplementation of the diet is an accepted mitigation strategy; however, the efficacy of individual oils is linked to their individual fatty acid composition. The objective of this study was to assess the effect of oils rich in polyunsaturated fatty acid (PUFA) on methane output, milk performance and rumen parameters of grazing dairy cows. Forty 5 Holstein Friesian cows were blocked on parity and allocated to 1 of 3 (n = 15) treatments, balanced for days in milk (mean 143 d ± 22) and pre-experimental milk yield (mean 24.6 l ± 4.8) in a randomized block design study. All animals had a daily grass allocation of 17kg dry matter (DM) plus 4kg of concentrate DM containing either 160g/kg FW of stearic acid (CO), soy oil (SO) or linseed oil (LO). Individual methane emissions were measured using the SF6 technique at 17 (PI) and 44 (PII) days post dietary introduction. Individual rumen samples were collected on d 22 and 49 for volatile fatty acid (VFA) and ammonia (NH3) analysis. Data were analyzed using the least squares procedures using the MIXED procedure of SAS. The statistical model used included the fixed effects of treatment, period and parity and appropriate interactions. Pre-experimental milk yield and days in milk were included in the model as covariates. Supplementary LO reduced ($P < 0.001$) methane emissions per kg of milk and milk solids produced compared with the CO or SO diets. Dietary LO reduced methane emissions per kg of dry matter intake ($P < 0.01$) compared with the SO diet. Dietary LO and SO supplementation increased ($P < 0.001$) milk yield and milk protein yield and had no effect on milk fat yield ($P < 0.001$) compared with the CO diet. Dietary PUFA supplementation reduced total rumen VFA concentrations ($P < 0.001$), NH3 concentrations ($P < 0.001$) and molar proportion of butyrate ($P < 0.001$) in the rumen. Dietary LO supplementation has the capacity to substantially reduce enteric methane emissions from grazing dairy cows while maintaining or enhancing milk production and composition.

Key Words: dairy cows, linseed oil, methane

422 Effects of different protein supplements on AA availability in dairy cows. G. Maxin,* D. R. Ouellet, and H. Lapierre, *Dairy and Swine Research and Development Center, Agriculture and Agri-Food Canada, Sherbrooke, QC, Canada.*

Canola meal (CM) or by-products of ethanol production (dried distillers grain, DDG) may offer an economical alternative to soybean meal (SBM) in North American dairy rations. Several studies have shown that these protein sources can effectively replace SBM, but few studies have focused on the AA availability. The objective of this study was to determine the effects of replacing SBM by either CM, high protein corn DDG with solubles (HPDDG) or wheat DDG with solubles (WDDG) on the availability of 3 AA: His, Lys and Met. Eight Holstein cows were used in a replicated 4 × 4 Latin square with 14-d periods. Cows were fed isoN (17.4%CP) diets formulated to slightly exceed energy and protein requirements (NRC, 2001) which contained 38% grass hay and 62% corn-based concentrate including either SBM, CM, HPDDG or WDDG as the protein source. The AA availability was estimated using the variation of whole body (WB) irreversible loss rate (ILR) of each AA, determined by the isotope dilution technique (Borucki Castro et al. 2008, Animal 2:224). A pulse dose of L-[$^{15}N_3$]His (0.18 g), L-[1-^{13}C]Met (0.12 g) and L-[α-^{15}N]Lys (0.55 g) was administered into one jugular vein. Blood samples were then collected from the other jugular vein at 1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 13, 16, 19, 25 and 31 min after the bolus injection to determine AA enrichments. The procedure was repeated at the end of the main study following a 7-d continuous abomasal infusion of Lys (70g/d) and Met (20g/d) with cows fed the SBM diet. As required by this technique, DMI, milk and milk protein yields were not affected by treatments and averaged 23.7, 31.4 and 1.14 kg/d. Preliminary results showed no difference in the WB ILR of Met and His among the treatments (122.1 ± 7.6, 128.4 ± 6.2 g/d), suggesting a similar availability of these 2 AA across diets. WB ILR of Lys was numerically ($P = 0.20$) higher with CM (352 g/d) and lower with HPDDG (291 g/d) than with SBM and WDDG (325 and 319 g/d). In comparison with the SBM diet, Lys and Met infusions increased ($P < 0.05$) Lys and Met WB ILR by 62.2 ± 30.5 and 24.8 ± 14.5 g/d, respectively, indicating that the above method is reliable to determine changes in AA availability.

Key Words: amino acids, dairy cow, protein sources