

(16/19), interval to estrus (52.8±2.77 h) and ovulation (78.51±3.09 h), ovulatory follicle size (10.55±0.55 mm), PR (5/19). In conclusion, a) compared to NCIDR devices, previously UCIDR devices are equally effective to induce estrus and ovulation synchronization with compa-

table PR in buffaloes during low breeding season and b) low dose FSH treatment at CIDR removal did not improve estrus expression or PR. *Acknowledgements: ALP, PARC.*

**Key Words:** Used CIDR, Pregnancy rates, FSH

## Ruminant Nutrition: Feed Additives

**470 Distillers grains-based diets with monensin supplemented with plant extracts: Effects on steer performance, carcass characteristics, and ruminal VFA concentrations.** A. L. Shreck<sup>\*1</sup>, N. A. Pyatt<sup>2</sup>, L. L. Berger<sup>1</sup>, J. M. Dahlquist<sup>1</sup>, T. G. Nash<sup>1</sup>, and D. Bravo<sup>3</sup>, <sup>1</sup>University of Illinois, Urbana, <sup>2</sup>ADM Research, Decatur, IL, <sup>3</sup>Pancosma, Geneva, Switzerland.

Performance data from early weaned (approximately 90 d of age) Simmental x Angus cross steers (n=140) were used to evaluate the effects of plant extracts in a distiller's grains-based feedlot diet with monensin. Steers were early weaned and backgrounded on a high-energy diet until allotment to a finishing trial. The basal diet consisted of 40% modified wet distiller's grains with solubles, 35% dry rolled corn, 15% corn silage, and 10% supplement. Treatments were: 1) monensin control (CON), 2) monensin + 133 mg•steer<sup>-1</sup>•d<sup>-1</sup> capsicum oleoresin (CAP; XT 6933 Pancosma), and 3) monensin + a blend of plant extracts (XT; 133 mg•steer<sup>-1</sup>•d<sup>-1</sup> eugenol+ cinnamaldehyde, and 67 mg•steer<sup>-1</sup>•d<sup>-1</sup> capsicum, XT 7065, Pancosma). Steers were individually fed using the GrowSafe automated feeding system (GrowSafe Systems Ltd, Airdrie, Alberta, Canada). Steers (initial BW 304±44 kg) were fed for 138 d and harvested at one time. There were no differences ( $P>0.05$ ) in HCW, LM area, G:F, or DMI. Steers consuming CAP tended ( $P=0.06$ ) to have higher ADG than CON or XT steers (1.93, 1.88 and 1.85 kg/d, respectively). CON or XT steers exhibited higher marbling scores (500=small) ( $P=0.01$ ) than CAP steers (577, 601, and 545, respectively). Steers fed XT or CAP had lower yield grades ( $P=0.01$ ) than CON steers (3.60, 3.58, and 3.90, respectively). Steers fed XT and CAP also had less 12th rib fat thickness ( $P<0.01$ ) than CON steers (14.9, 16.5, 17.5 mm, respectively). VFA concentrations or acetate:propionate ratio (C2:C3) did not differ even though steers consuming CAP had numerically higher C2:C3 ratio (3.2) than CON (2.3) or RMB (2.6). Five animals per treatment limited our ability to detect differences. Including capsicum or a blend of eugenol, cinnamaldehyde, and capsicum in distiller's grains-based diets in conjunction with monensin did not impact finishing performance but may result in leaner carcasses with lower yield grades.

**Key Words:** beef, plant extracts, performance

**471 Meta analysis of growing ruminants fed a mixture of eugenol, cinnamaldehyde and capsicum oleoresin.** D. Bravo<sup>\*1</sup>, N. A. Pyatt<sup>2</sup>, P. H. Doane<sup>2</sup>, and M. J. Cecava<sup>2</sup>, <sup>1</sup>Pancosma, Geneva, Switzerland, <sup>2</sup>ADM Research, Decatur, IL.

The objective of this study was to use meta analysis to evaluate whether a plant extract mixture consistently affected the productive performance of growing ruminants. Research was conducted by Pancosma and ADM on XTract 7065 (XT) containing 17% eugenol, 11% cinnamaldehyde, and 7% capsicum oleoresin. Systematic search identified 13 studies organized in 18 trials (884 growing ruminants) with trials on growing sheep (n = 3) and beef cattle (n = 15). Effects of XT were investigated using mixed model analysis and effect size calculation (ES). Treatment means, ES values and 95% confidence intervals (CI) were determined for DMI, ADG and feed efficiency (G:F). Homogeneity was addressed using the  $I^2$  statistic, and publication bias examined with the test of Begg.

XT tended to improve ADG for beef (+2.9%, ES = 0.131, CI = -0.004 to 0.266,  $P = 0.06$ ) and lambs (+16.8%, ES = 0.489, CI = -0.066 to 1.044,  $P = 0.08$ ). XT did not alter DMI for lambs ( $P = 0.24$ ) or beef cattle ( $P = 0.81$ ). Thus, there was a trend for improved feed efficiency with XT in beef (+2.6%, ES = 0.455, CI = -0.072 to 0.982,  $P = 0.09$ ) and lambs (+11.9%, ES = 0.110, CI = -0.044 to 0.264,  $P = 0.16$ ). Studies identified did not exhibit publication bias for ADG, DMI or G:F ( $P > 0.10$ ). DMI for cattle was heterogeneous ( $I^2 = 40.2\%$ ,  $P = 0.10$ ), indicating response to XT was dependent on an environmental factor. Among moderating variables, dietary ionophore explained the heterogeneity of DMI ( $P = 0.19$ ). Ionophore did not alter ADG response to XT ( $P = 0.83$ ), but DMI was lower with addition of XT when ionophore was present, with ES for DMI of -0.061 and 0.213 in presence or absence of ionophore respectively. The interaction of ionophore and XT was not significant for G:F although the ES increased with ionophore. Correlation analysis of diet composition among trials suggested improved efficacy of XT in high-energy (NEg, starch, or concentrate) and/or low NDF diets. This analysis showed consistent improvements in growth and efficiency for growing ruminants fed a blend of eugenol, cinnamaldehyde and capsaicin.

**Key Words:** beef cattle, plant extracts, meta analysis

**472 Synergy of cinnamaldehyde, eugenol and garlic for reduction of methane production in vitro.** S. Cavini<sup>1</sup>, D. Bravo<sup>\*2</sup>, S. Calsamiglia<sup>1</sup>, M. Rodriguez<sup>1</sup>, A. Ferret<sup>1</sup>, and G. Schroeder<sup>3</sup>, <sup>1</sup>Universitat Autònoma de Barcelona, Barcelona, Spain, <sup>2</sup>Pancosma, Geneva, Switzerland, <sup>3</sup>Cargill, Elk River, MN.

The effect of combination of eugenol (E), cinnamaldehyde (C) and a garlic botanical standardized for propyl propyl thiosulfonate (G) on in vitro microbial fermentation was determined using a simplex centroid experimental design of degree 3 with 3 components. Treatments were mixtures between the 3 extracts totalling 250 mg/L and composed of (doses in mg/L) 1) 125G + 125C + 0E; 2) 0G + 250C + 0E; 3) 250G + 0C + 0E; 4) 41.7G + 41.7C + 166.7E; 5) 41.7G + 166.7C + 41.7E; 6) 0G + 0C + 250E; 7) 0G + 125C + 125E; 8) 166.7G + 41.7C + 41.7E; 9) 125G + 0C + 125E; and 10) 83.3G + 83.3C + 83.3E. Two controls were also used: negative control (CTR) and 500 mg/L of monensin (MON). Each treatment was tested in duplicate and in two periods. Fifty millilitres of a 1:1 ruminal fluid-to-buffer solution were introduced into polypropylene tubes supplied with 0.5 g of DM of a 60:40 forage:concentrate diet and incubated for 24h at 39C. Samples were collected for VFA and methane concentrations (CH<sub>4</sub>). Results were analysed with SAS using a special cubic model. Total VFA were unaffected by the 3 extract combinations. The molar proportion of acetate was decreased by C×G ( $P = 0.015$ ) and by C×G×E ( $P = 0.023$ ) whereas the molar proportion of butyrate was increased by C×G ( $P = 0.004$ ) and by E×C×G ( $P = 0.024$ ). The molar proportion of valerate was decreased by E×C ( $P = 0.042$ ), by E×G ( $P = 0.116$ ) and increased by C×G ( $P = 0.081$ ) and E×C×G ( $P = 0.021$ ). Concentration of CH<sub>4</sub> for treatments 10, 5 and 4 were lower than CTR (17.96, 18.46, 18.49 and 22.2, respectively;  $P < 0.001$ ) and higher than MON (5.81,  $P < 0.001$ ). Concentration of CH<sub>4</sub> was affected by the

combination E×C ( $P = 0.033$ ) and decreased by E×C×G ( $P = 0.012$ ). The regression predicting CH<sub>4</sub> concentration with the 3 compounds is: CH<sub>4</sub> = 0.078 E + 0.077 C + 0.096 G + 0.000356 E×C - 0.000012 E×C×G ( $P = 0.012$ , RSD = 1.61, R<sup>2</sup> = 0.79). Results demonstrate that there is a synergy between the 3 extracts for the reduction of methane *in vitro*.

**Key Words:** essential oils, rumen fermentation, methane

**473 Essential oils may reduce the risk of ketosis in dairy goats carrying twins.** S. Calsamiglia<sup>1</sup>, S. Cavini<sup>1</sup>, A. Bouattour<sup>1</sup>, A. Ferret<sup>1</sup>, and D. Bravo<sup>\*2</sup>, <sup>1</sup>Universitat Autònoma de Barcelona, Bellaterra, Spain, <sup>2</sup>Pancosma, Switzerland.

Dairy goats carrying twins are highly susceptible to gestational ketosis as the result of an unbalance between energy supply and requirements. The hypothesis was that by increasing intake and glucose precursors (propionate), the indicators of ketosis will be reduced. Pregnant Murciano-Granadina goats ( $n = 24$ ) carrying twins were used to study the effects of feeding capsicum (to stimulate intake) and eugenol plus cinnamaldehyde (to promote propionate production in the rumen) on intake, milk production and composition, and blood profile. Goats were controlled from 2 wk prior to 6 wk after kidding. Goats received the same 60:40 forage:concentrate diet during the pre and postpartum periods. Treatments were a control (CTR; no additive) and essential oil supplementation (XT; 75 mg of eugenol, 45 mg of cinnamaldehyde and 27 mg of capsicum). Intake and milk production were recorded daily, milk composition determined weekly, and blood samples taken days -15, -7, -3, -2, -1, 0, 1, 2, 3, 5, 7 and 15 around kidding to measure insulin, glucose, non-esterified fatty acids (NEFA), triglycerides and beta-hydroxy-butyrate (BOHB). Results were analyzed using the PROC MIXED procedure of SAS and differences declared at  $P < 0.05$ . Intake tended ( $P < 0.07$ ) to increase in the XT treatment with no effects on milk production (1.93 L/d). However, milk fat (6.48 vs 5.84%) and protein (3.86 vs 3.69%) were higher in XT compared with CTR. Prepartum, plasma glucose concentration tended ( $P < 0.09$ ) to be higher (58.2 vs 54.5 mg/dL), insulin was lower (0.45 vs 0.62  $\mu$ g/L), and NEFA tended ( $P < 0.09$ ) to be lower (0.22 vs 0.33 mmol/L) in the XT treatment compared with CTR, with no treatment effects on blood BOHB (0.30 mmol/L) and triglycerides (0.31 mg/mL). In the postpartum, only BOHB was affected by treatment, being lower in XT compared with CTR (0.52 vs 0.63 mmol/L). Results suggest that the XT reduce body fat mobilization.

**Key Words:** goats, ketosis, essential oils

**474 Effects of feeding an essential oil complex on whole tract nutrient digestion and productive performance of lactating dairy cows.** M. B. Santos<sup>\*1,2</sup>, P. H. Robinson<sup>1</sup>, and P. Williams<sup>3</sup>, <sup>1</sup>University of California, Davis, <sup>2</sup>CECAV-UTAD, Vila Real, Portugal, <sup>3</sup>Advantec Associates, Davis, CA.

Essential oils (EO) have been shown to positively impact *in vitro* ruminal fermentation, but there are few *in vivo* studies that have examined animal responses. Our objective was to evaluate the efficacy of an EO complex (Agolin Ruminant from AGOLIN SA, Bière, Switzerland), which contained eugenol, geranylacetate and coriander oil as major components, on production of lactating dairy cows (DC), measures of efficiency of use of dietary N as well as whole tract digestion of nutrients. Two pens of approximately 310 early lactation multiparous cows were used in a 2×2 factorial experiment with treatment reversed 28 day periods. Cows were fed a totally mixed ration (TMR) twice daily for *ad*

*libitum* intake based on wheat silage (13.6% TMR (DM)), maize grain (12.9%), alfalfa hay and fresh chop 5.5%) and corn silage (6.3%). The basal TMR was the same for both treatment groups, and differed only in that the EO complex was added to the TMR of the EO assigned pen. Feed premixes, TMR and ingredients were sampled on days 21 and 26 of each experimental period. Cows were milked 3 times daily with milk yield and components measured at the end of each period. Urine samples were collected from 24 cows/pen that voluntarily urinated at the end of each period, with fecal collections from these same cows 24 h later. Actual refusals corrected EO feeding level was 0.85 g/cow/day. The TMR contained 54.7% DM, 16.4% CP, 6.2% EE, 32.2% NDF and 12.0% starch. DM intake was numerically (i.e.,  $P=0.13$ ) lower with EO feeding (i.e., 26.0 vs. 27.4 kg/d) but milk yield was not impacted (mean 49.2 kg/d). However milk fat (MF) production (1.63 vs. 1.66 kg/d;  $P=0.02$ ) and MF proportion (33.2 vs. 33.9 g/kg;  $P<0.001$ ) were higher for cows fed EO. There was also a numerically 6.9% higher (i.e., 0.698 vs. 0.746;  $P=0.17$ ) efficiency of use of dietary net energy for milk energy output. There were no differences in urine parameters or whole tract digestion of OM, CP and NDF. Feeding this EO complex positively impacted performance of high producing DC, primarily by enhancing MF synthesis, suggesting that it may have enhanced acetate and/or propionate production

**Key Words:** essential oils, dairy

**475 Effects of an encapsulated combination of cinnamaldehyde and garlic oil on early and late lactating Red Simmental dairy cows.** C. Kamel<sup>\*1</sup>, H. M. R. Greathead<sup>1</sup>, and P. W. Cardozo<sup>2</sup>, <sup>1</sup>School of Biology, University of Leeds, Leeds, United Kingdom, <sup>2</sup>Carotenoid Technologies, IQF Group, Tarragona, Spain.

Two feeding trials were carried out in lactating Red Simmental dairy cows to determine the effects of an encapsulated combination (NE 300) of cinnamaldehyde (129 mg/day as fed) and garlic oil (standardized in diallyl disulfide, 15 mg/day as fed). It was hypothesized that NE 300 effects would depend on microbial populations, and thus remain unaffected by the lactation status of the animal. In Trial 1, 24 Red Simmental (Red Holstein x Simmental) dairy cows were fed a forage-based diet over a 12 week period in late lactation (DIM > 200 days) with 2 kg/day of a high protein (40g/g CP) in a ration based on grass silage and hay *ad libitum*. After a 1-week covariant pre-trial period, cows were assigned randomly to control (CON) or treatment (NE 300) diet. Concentrate intake and milk production were recorded at morning and evening feedings, and milk composition taken as well for analysis of milk protein, fat and lactose percentage, milk urea nitrogen (MUN) and somatic cell counts (SCC). Highly significant ( $P < 0.001$ ) differences for MUN were recorded over the study for NE 300 versus CON. NE 300 also showed significant ( $P > 0.05$ ) decreases in SCC versus CON over the trial period. All other parameters were unaffected, except in the final month when milk production was higher ( $P < 0.05$ ) for NE 300 versus CON. In Trial 2, 67 Red Simmental (Red Holstein x Simmental) dairy cows including some of the same animals carried over from Trial 1 were fed the same forage-based diet over an 8 week period in early lactation (DIM < 100 days) using the same trial as in Trial 1. Feeding of NE 300 showed a tendency to decrease MUN ( $P < 0.07$ ) versus CON over the entire trial period, decreasing by 13% in the final month ( $P > 0.05$ ). In addition, protein percentage ( $P < 0.08$ ) tended to increase over the course of the study. All other parameters were unaffected. The results of this study show that feeding of NE 300 in early and late lactation diets consistently reduces MUN levels in the milk, and in early lactation may tend to have an effect on increasing milk protein level.

**Key Words:** cinnamaldehyde, garlic oil, dairy cows

**476 Yeast culture supplementation interacts with voluntary feed intake to affect ruminal starch digestion.** Y. Ying\* and M. S. Allen, Michigan State University, East Lansing.

This experiment was conducted to evaluate responses of ruminal digestion of starch to yeast culture supplementation and if responses are influenced by voluntary feed intake. Fifteen ruminally and duodenally cannulated Holstein cows with a wide range in preliminary voluntary DMI (pVDMI; 20.1 to 31.0 kg/d) measured during a 14-d preliminary period were utilized in a crossover design experiment. Treatments were Diamond V XP™ Yeast Culture (YC) and control (a mix of dry ground corn and soybean meal), top-dressed at the rate of 56 g/d per head. The base diet contained 28% NDF, 30% starch, and 16.5% CP and included corn silage, alfalfa silage, high moisture corn, protein supplement, and a mineral and vitamin supplement. Treatment periods were 28 d with the final 8 d used for sample and data collection. Voluntary DMI was determined during the last 4 d of the preliminary period. Ruminal digestion kinetics were determined using the pool-and-flux method and visual observations of feeding behavior were recorded every 5 min for 24 h per period. Main effects of YC treatment and their interaction with pVDMI were tested by ANOVA. An interaction ( $P < 0.01$ ) was detected between YC treatment and pVDMI for ruminal digestion rate of starch (mean = 37.0%/h); YC increased rate of starch digestion compared to control for cows with pVDMI below 26 kg/d and decreased it for cows with higher pVDMI. This resulted in an interaction between treatment and pVDMI for turnover rate of starch in the rumen ( $P = 0.03$ ) and true and apparent ruminal starch digestibility (tendency,  $P < 0.13$ ) because passage rate of starch from the rumen was not affected by treatment (mean = 16.5%/h). Ruminal pH (mean = 6.0), DMI, milk yield and component percentages were not affected by treatment or its interaction with pVDMI. Yeast culture supplementation reduced the rate of ruminal starch digestion for cows with higher feed intake which could help stabilize the rumen environment when large amounts of starch are consumed to support higher milk production.

**Key Words:** digestion kinetics, site of digestion, rate of digestion

**477 Effect of yeast culture on ruminal fermentation and nutrient utilization in dairy cows.** A. N. Hristov\*<sup>1</sup>, G. Varga<sup>1</sup>, T. Cassidy<sup>1</sup>, M. Long<sup>1</sup>, K. Heyler<sup>1</sup>, C. J. Hovde<sup>2</sup>, and I. Yoon<sup>3</sup>, <sup>1</sup>Pennsylvania State University, University Park, <sup>2</sup>University of Idaho, Moscow, <sup>3</sup>Diamond V Mills, Cedar Rapids, IA.

The goal of this experiment was to investigate the effect of yeast culture (*Saccharomyces cerevisiae*) on rumen fermentation and nutrient utilization in high-producing dairy cows. Eight ruminally cannulated Holstein cows were allocated to two dietary treatments in a crossover design. Treatments were Control (no yeast culture) and YC (yeast culture: XP™, Diamond V Mills, Inc. fed at 56 g/head/d). The basal diet had 16% CP, 32% NDF, and estimated 1.71 Mcal NE<sub>L</sub>/kg. Within each period, cows were adapted to the treatment for 21 d before sample collections. Dry matter intake (27.4 and 27.6 kg/d, Control and YC, respectively), milk yield (46.5 vs. 46.4 kg/d), BW, and milk composition were similar ( $P = 0.13$  to 0.95) between treatments. Milk urea nitrogen concentration was also not affected ( $P = 0.73$ ) by treatment. Rumen pH was similar ( $P = 0.18$ ) between the Control (6.03) and YC (5.96), but rumen ammonia concentration tended ( $P = 0.08$ ) to be lower with YC (3.03) than with the Control (3.61 mM). Treatment had no effect ( $P = 0.15$  to 0.90) on concentrations of total or individual VFA. Urinary N losses did not differ ( $P = 0.12$ ) between treatments, but allantoin and total purine derivative excretions and the estimated microbial N outflow from the rumen (513 vs. 471 g/d, respectively) tended to be increased ( $P = 0.08$  to 0.10) by

YC compared with the Control. Cumulative ammonia and methane emissions from manure were decreased by YC ( $P < 0.001$  and 0.002). Total tract apparent digestibility of DM, OM, N, and NDF were not affected ( $P = 0.46$  to 0.65) by YC. Concentration of C16:0 in milk fat was decreased ( $P = 0.03$ ) and that of C18:0 was increased ( $P = 0.008$ ) by YC compared with the Control. The yeast culture tested had little effect on ruminal fermentation, digestibility, and N losses, but tended to reduce rumen ammonia concentration and increase microbial protein synthesis and decreased ammonia and methane emissions from manure.

**Key Words:** yeast culture, rumen fermentation, dairy cow

**478 Production response to soybean meal and methionine supplementation of corn silage-based diets in dairy cows.** M. Gonzalez Ronquillo\*<sup>1</sup>, H. Nursoy<sup>2</sup>, G. A. Broderick<sup>3</sup>, and A. P. Faciola<sup>4</sup>, <sup>1</sup>Universidad Autonoma del Estado de Mexico, Toluca, Mexico, <sup>2</sup>Yuzuncu Yil University, Van, Turkey, <sup>3</sup>U.S. Dairy Forage Research Center, Madison, WI, <sup>4</sup>University of Wisconsin, Madison.

Corn silage, a major forage fed to dairy cows throughout the world, is energy rich but protein poor. Our objective was to identify the optimal level with which to supplement CP, as soybean meal (SBM), in corn silage-based diets to support of production of milk and milk components. A constant supplement of rumen-protected Met (RPM; Mepron®) was added to SBM to improve its AA balance. Thirty-six cows were blocked by parity and DIM into 9 blocks and randomly assigned to 9 balanced 4 x 4 Latin squares with 4, 16-wk periods. All diets were formulated to contain (DM basis) 50% corn silage, 10% alfalfa silage, 4% soyhulls, 2.4% mineral-vitamin supplement, 42% NFC and 30% NDF. Ground high moisture and dry corn was reduced and SBM plus RPM increased to give diets containing: 12% CP (28% corn, 6% SBM; 4.5 g RPM/d), 14% CP (23% corn, 10% SBM, 9 g RPM/d), 16% CP (19% corn, 15% SBM, 13.5 g RPM/d), and 18% CP (14% corn, 19% SBM, 18 g RPM/d). Data from the last 14-day of each period were analyzed using proc mixed in SAS; LS means are reported in the table. With the exception of milk fat content, there were significant effects of diet ( $P \leq 0.02$ ), and linear effects of dietary CP ( $P \leq 0.03$ ), on all production traits. Mean separation indicated that there was no improvement above 14% CP in most cases. However, yield of milk and true protein were both lower on 12 and 14% than on 16 and 18% dietary CP. Results indicated that 16% CP was required to optimize production in dairy cows fed corn silage-based diets supplemented with SBM plus RPM.

**Table 1.**

| Item          | Dietary CP        |                    |                    |                   | Probability |        |
|---------------|-------------------|--------------------|--------------------|-------------------|-------------|--------|
|               | 12%               | 14%                | 16%                | 18%               | Diet        | Linear |
| DMI, kg/d     | 23.8 <sup>b</sup> | 25.4 <sup>a</sup>  | 25.2 <sup>a</sup>  | 25.8 <sup>a</sup> | <0.01       | <0.01  |
| Milk, kg/d    | 35.3 <sup>c</sup> | 38.7 <sup>b</sup>  | 39.2 <sup>ab</sup> | 40.5 <sup>a</sup> | <0.01       | <0.01  |
| Milk/DMI      | 1.49 <sup>b</sup> | 1.53 <sup>ab</sup> | 1.56 <sup>a</sup>  | 1.58 <sup>a</sup> | <0.01       | <0.01  |
| Fat, %        | 3.81              | 4.08               | 3.91               | 3.97              | 0.40        | 0.55   |
| Fat, kg/d     | 1.30 <sup>b</sup> | 1.55 <sup>a</sup>  | 1.52 <sup>a</sup>  | 1.59 <sup>a</sup> | <0.01       | <0.01  |
| Protein, %    | 3.13 <sup>b</sup> | 3.24 <sup>a</sup>  | 3.22 <sup>a</sup>  | 3.27 <sup>a</sup> | <0.01       | <0.01  |
| Protein, kg/d | 1.08 <sup>c</sup> | 1.22 <sup>b</sup>  | 1.24 <sup>ab</sup> | 1.30 <sup>a</sup> | <0.01       | <0.01  |
| SNF, %        | 8.71 <sup>b</sup> | 8.95 <sup>a</sup>  | 8.84 <sup>ab</sup> | 8.96 <sup>a</sup> | 0.02        | 0.03   |
| SNF, kg/d     | 3.04 <sup>c</sup> | 3.39 <sup>b</sup>  | 3.42 <sup>ab</sup> | 3.59 <sup>a</sup> | <0.01       | <0.01  |
| MUN, mg/dl    | 5.7 <sup>d</sup>  | 8.0 <sup>c</sup>   | 10.6 <sup>b</sup>  | 14.9 <sup>a</sup> | <0.01       | <0.01  |

<sup>a-d</sup>Means with different superscripts differ ( $P < 0.05$ )

**Key Words:** corn silage, soybean meal, rumen-protected methionine

**479 Effects of dietary antioxidants, trace minerals and calcium salt of 2-hydroxy-4-methylthio butanoic acid (Ca-HMTBa) supplementation on lactation performance.** G. R. Bowman<sup>\*1</sup>, M. Vázquez-Añón<sup>1</sup>, D. E. Diaz<sup>1</sup>, and J. Nocek<sup>2</sup>, <sup>1</sup>Novus International, Inc., St. Charles, MO, <sup>2</sup>Spruce Haven Research, Union Springs, NY.

Forty-five lactating Holstein dairy cows housed in tie stalls were used to evaluate the effects of providing combinations of a dietary antioxidant blend, Ca-HMTBa and chelated trace minerals (AGRADO<sup>®</sup> Plus, MFP<sup>™</sup>, and MINTREX<sup>®</sup> Zn, Cu, and Mn; respectively, Novus International) on lactation performance. All cows received a control diet from calving until 14 DIM. Cows were randomly assigned by milk volume at 7 DIM to one of three treatments; control (CON), 5.5 g of antioxidant blend with 2 g of zinc, 1.5 g of Mn, and 0.5 g of Cu chelated minerals (MA), and MA with 22 g of Ca-HMTBa (MAM). All treatments were formulated to contain the same concentration of total Zn, Mn, and Cu. Data was segmented into three separate phases that were characterized by DIM; phase 1 = 29 to 56 DIM, phase 2 = 57 to 84 DIM, and phase 3 = 85 to 112 DIM. Data was analyzed using the MIXED procedure in SAS; weekly averages were used for repeated measures with subject being cow within treatment. There were no differences observed for any of the production parameters measured for phases 1 and 2. In phase 3, cows receiving treatment MAM increased milk production, 3.5% fat corrected milk, efficiency (kg milk/kg DMI), and protein yield when compared to CON (Table 1). Cows supplemented with MA had numerically increased milk volume and decreased DMI which led to an improvement in efficiency when compared to CON for phase 3 (Table 1). No changes in body condition score or weight were observed between the beginning and end of the experiment. With treatment differences occurring in phase 3 the combinations chosen in this study improve persistency of lactation and efficiency.

**Table 1. Lactation performance during phase 3.**

|              | CON                | MA                  | MAM                | SE    |
|--------------|--------------------|---------------------|--------------------|-------|
| DMI, kg      | 25.63              | 24.50               | 25.35              | 0.652 |
| Milk, kg     | 37.96 <sup>a</sup> | 40.22 <sup>ab</sup> | 41.72 <sup>b</sup> | 1.302 |
| 3.5% FCM, kg | 36.26 <sup>a</sup> | 37.84 <sup>ab</sup> | 40.63 <sup>b</sup> | 1.488 |
| Efficiency   | 1.51 <sup>a</sup>  | 1.65 <sup>b</sup>   | 1.66 <sup>b</sup>  | 0.049 |
| Fat, %       | 3.21               | 3.14                | 3.34               | 0.137 |
| Protein, %   | 2.82               | 2.92                | 2.94               | 0.052 |
| Fat, kg      | 1.22               | 1.26                | 1.39               | 0.068 |
| Protein, kg  | 1.07 <sup>a</sup>  | 1.17 <sup>ab</sup>  | 1.23 <sup>b</sup>  | 0.041 |

<sup>a,b</sup>  $P < 0.05$

**Key Words:** antioxidant, minerals, milk production

**480 High-fat or low-fat distillers grains with dry or high-moisture corn in diets containing monensin for dairy cows.** T. M. Owens<sup>\*1</sup>, A. R. Hippen<sup>1</sup>, K. F. Kalscheur<sup>1</sup>, D. J. Schingoethe<sup>1</sup>, D. L. Prentice<sup>2</sup>, and H. B. Green<sup>2</sup>, <sup>1</sup>South Dakota State University, Brookings, <sup>2</sup>Elanco Animal Health, Greenfield, IN.

Forty-eight lactating Holstein cows were used in a 6-wk study to determine the effects of dietary unsaturated fat from corn distillers grains (DG) and starch fermentability in a 2 × 2 factorial arrangement. Effects of unsaturated fat were evaluated by replacing DG with a low-fat DG (Dakota Gold HP; HP). Effects of fermentability of starch were evaluated by replacing dry ground corn (DC) with high-moisture (wet) corn (WC). The DG diets contained 2% fat from DG (DM basis). Energy Booster 100 was added to the HP diets to balance fat across diets. All diets contained 15 g/ton monensin and 15.2% starch from DC or WC.

Though BW tended to increase for cows fed DC compared with WC ( $P = 0.06$ ), BCS and DMI were not affected. Feeding DC tended to increase ( $P = 0.09$ ) ammonia and proportions of acetate and isovalerate ( $P = 0.03$ ) in ruminal fluid compared with WC. Feeding DG compared with HP decreased the proportion of acetate ( $P < 0.02$ ) as well as acetate:propionate ratio ( $P = 0.01$ ) and increased the concentration and proportion of propionate ( $P < 0.04$ ). Feeding DC increased milk yield (35.7 vs. 33.6 kg/d for WC,  $P = 0.05$ ). Yield and percentage of milk fat were decreased for cows fed DG compared with HP (1.02 vs. 1.20 kg/d and 2.95 vs. 3.42%,  $P < 0.01$ ) and yield was decreased for WC compared with DC (1.17 vs. 1.05 kg/d,  $P = 0.01$ ). The decrease in milk fat yield and percentage were greatest for cows fed DGWC (0.90 kg/d and 2.76%,  $P = 0.01$ ). Cows fed WC had increased milk protein percentage (3.14 vs. 3.03% for DC,  $P = 0.05$ ). Yield of FCM was greater for HP compared with DG (32.0 vs. 29.3 kg/d,  $P = 0.01$ ) and for DC compared with WC (31.9 vs. 29.3 kg/d,  $P = 0.02$ ). The HP diets increased efficiency of FCM (1.50 vs. 1.33 kg milk/kg DMI for DG,  $P = -0.02$ ). Feeding DG with WC decreased yield of FCM (26.8 kg/d,  $P < 0.04$ ) and tended to decrease efficiency ( $P = 0.10$ ). In summary, feeding DG in combination with WC decreased milk fat and FCM compared with feeding WC in a diet containing saturated fat.

**Key Words:** fat saturation, starch fermentability, distillers grains

**481 Effect of marine algae (ALG) on milk production characteristics and fatty acid (FA) composition in early lactating dairy cows.** B. Vlaeminck<sup>\*1</sup>, M. Hostens<sup>2</sup>, G. Opsomer<sup>2</sup>, and V. Fievez<sup>1</sup>, <sup>1</sup>Laboratory for Animal Nutrition and Animal Product Quality, Ghent University, Melle, Belgium, <sup>2</sup>Department of Reproduction, Obstetrics and Herd Health, Ghent University, Merelbeke, Belgium.

Sixteen Holstein cows were randomly assigned to 2 groups according to expected calving date, estimated milk and fat production and genetic origin to evaluate the effect of feeding ALG during early lactation on milk production characteristics and FA profiles. All cows were housed in a loose stable as a single group and received a TMR (corn and grass silage, soybean meal, sugar beet pulp, corn cob mix, hay and minerals; 53.2, 24.2, 10.0, 4.5, 5.7, 2.0% on DM basis). Control cows received 2kg of protein rich concentrate and between 6 and 8kg of a balanced dairy concentrate, according to their requirements. In the ALG group, 2kg of the latter was replaced by an iso-energetic concentrate containing ALG (11% on product basis), starting 3 weeks prior to the expected calving date. Concentrates were provided by means of an automatic concentrate feeder. Milk parameters were monitored weekly during the first 12 weeks of lactation in 24h milk samples. ALG increased milk yield (41.2 vs 38.2 kg/d,  $P=0.057$ ), whereas milk fat yield (1.18 vs. 1.49 kg/d,  $P=0.005$ ) and content (30.6 vs. 41.4 g/kg,  $P=0.011$ ) decreased. Protein yield ( $P=0.465$ ) was not affected whereas a tendency for reduced protein content (32.9 vs. 34.7 g/kg,  $P=0.094$ ) was observed. Dietary effects on milk production characteristics were independent ( $P>0.05$ ) of week after parturition. Proportions of short-chain FA (g/100 g milk FA) (6:0 to 12:0) decreased ( $P<0.05$ ) in milk fat of ALG cows whereas 4:0, 14:0 and 16:0 were not affected ( $P>0.05$ ). ALG resulted in marked alterations in milk C18-FA, changes that were characterized as a reduction ( $P<0.05$ ) in 18:0 (5.92 vs. 11.7) and cis-9-18:1 (18.4 vs. 23.6) and an increase in trans-10-18:1 (5.00 vs. 0.42), trans-11-18:1 (4.70 vs. 1.23), trans-11, cis-15-18:2 (0.28 vs. 0.08), cis-9, trans-11-18:2 (1.37 vs. 0.44) and trans-9, cis-11-18:2 (0.07 vs. 0.01). Milk from cows receiving ALG had greater concentrations of 22:6n-3 (0.20 vs. 0.01,  $P<0.001$ ). In conclusion, supplementation of ALG to early lactating dairy cows resulted in a decreased milk fat production possibly related to an altered rumen biohydrogenation.

**Key Words:** dairy cow, marine algae, early lactation