Graduate Student Competition: ADSA Production Division Oral Competition, PhD Division

23 High feed efficiency for milk is associated with high feed nitrogen efficiency in dairy cows. C. Arndt*[1], M. A. Wattiaux[1], J. M. Powell[2], and M. J. Aguerre[1], *[1]Department of Dairy Science, University of Wisconsin, Madison, [2]USDA-Agricultural Research Service, US Dairy Forage Research Center, USDA-ARS, Madison, WI.*

Greater feed N efficiency for milk N could enhance dairy farm profits and reduce manure N excretion and environmental risks. The objective was to evaluate relationships between feed efficiency for milk (FEmk, kg milk/kg DMI) and measures of feed N efficiency in dairy cows. Eight pairs of mid-lactating cows (primiparous or multiparous <16 DIM apart within each pair) with high and low FEmk of 1.78 and 0.98 kg/kg, respectively, were fed a TMR (47% DM) consisting of 28% corn silage, 27% alfalfa silage and 45% concentrate, containing 16% CP and 28% NDF (DM basis) for at least 4 weeks. During a 3-d period TMR, feed refusals, milk, total feces and total urine were measured, sampled daily and analyzed for N concentrations. Data were analyzed as a randomized complete block with cow pairs as blocks and FEmk as treatment. High FEmk cows had 15% greater N intake (NI), 32% greater fecal N (FN) excretion and 5% lower apparent N digestibility than low FEmk cows (see Table 1). Despite similar digested N high FEmk cows secreted 1.9 times more N in milk than low FEmk cows, yet urine N (UN) and manure N (FN + UN) excretion were similar. High FEmk cows had greater feed N efficiencies (30% of NI secreted as milk N) than low FEmk cows (19%). Also, high FEmk cows excreted 45% less manure N/milk N and manure UN to FN ratio was 30% lower than in low FEmk cows. High FEmk cows were more feed N efficient due to metabolic rather than digestive processes. Selection for high FE cows may increase feed energy utilization as well as feed N utilization and decrease risk of manure ammonia and nitrous oxide emissions due to reduced manure UN to FN ratio.

Table 1.

Item	FEmk1		SEM	*P*-value
	High	Low		
N intake, g/d	641	559	22.9	0.01
N digestibility, %	63.8	67.1	1.01	0.06
Digested N, g/d	409	376	17.0	0.12
Milk N, g/d	193	102	10.2	<0.01
Fecal N, g/d	210	159	8.6	<0.01
Urine N, g/d	210	226	15.4	0.40
(Fecal N + Urine N), g/d	420	384	21.8	0.18
Milk N/N intake, %	30.3	18.5	1.97	<0.01
Milk N/digested N, %	47.5	27.6	2.98	<0.01
Manure N/milk N, g/g	2.17	3.97	NA	<0.01
Urine N/Fecal N, g/g	1.00	1.42	0.07	<0.01

[1]FEmk = feed efficiency for milk (kg milk/kg DMI).

Key Words: feed efficiency, nitrogen efficiency, dairy cattle

24 Tumor necrosis factor-α injection promotes liver inflammation and decreases gluconeogenesis in early lactation dairy cows. K. Yuan*[1], J. K. Farney[1], L. K. Mamedova[1], L. M. Sordillo[2], and B. J. Bradford[1], *[1]Kansas State University, Manhattan, [2]Michigan State University, East Lansing.*

The first week of lactation in dairy cows is characterized by substantial metabolic stress and high rates of metabolic disorders. We hypothesized that inflammation may contribute to these problems. Therefore, we tested whether administering an inflammatory cytokine, recombinant bovine tumor necrosis factor-α (TNFα), affects liver inflammation, gluconeogenesis, and metabolism during this period. Thirty-three Holstein cows (9 primiparous and 24 multiparous) were randomly assigned to 1 of 3 treatments at parturition. Treatments were 0, 1.5, or 3.0 μg/kg BW TNFα, and were administered once daily by subcutaneous injection for the first 7 d of lactation. Plasma samples were collected daily for analysis of metabolites and hormones, and liver samples were collected on d 7 for triglyceride and qPCR analyses. Glucose turnover rate was determined by a U-^{13}C-glucose dilution technique on d 7 to estimate gluconeogenic rate. Data were analyzed using mixed models with repeated measures over time and significance was declared at $P < 0.05$ and tendencies at $P < 0.10$. Preplanned contrasts evaluating control vs. TNFα treatments and low vs. high doses were evaluated. The TNFα treatments increased ($P < 0.01$) concentrations of plasma haptoglobin, but did not affect plasma insulin, nonesterified fatty acids, glucose, β-hydroxybutyrate, triglyceride, 3-methylhistidine, or liver triglyceride. Plasma TNFα concentrations tended to be increased when quantified 16 h after daily TNFα administration. Few plasma eicosanoids were affected by treatment, but surprisingly, TNFα administration decreased prostaglandin D_2 and leukotriene D_4 concentrations. Hepatic carnitine palmitoyltransferase 1a transcript abundance increased in a TNFα dose-dependent manner. Plasma glucose turnover rate tended to be decreased 18% by TNFα administration, suggesting impaired glucose production. Taken together, these results indicate that administration of TNFα daily for the first 7 d of lactation increased hepatic inflammation, tended to decrease gluconeogenesis, but did not affect liver triglyceride accumulation or lipid metabolism in dairy cows.

Key Words: gluconeogenesis, metabolism, tumor necrosis factor-α

25 Efficacy of on-farm use of ultraviolet light for inactivation of bacteria in milk for calves. S. L. Gelsinger*, A. J. Heinrichs, C. M. Jones, R. J. Van Saun, C. M. Burns, and H. R. Lysczek, *The Pennsylvania State University, State College.*

UV light has been suggested as an alternative method to heat for bacterial inactivation in milk for calves. However, limited data are available to show the efficacy of this method. Thus, the objective of this study was to investigate the efficacy of on-farm UV (UV) light treatment in reducing bacteria levels in waste milk used for feeding calves. Samples were collected from 9 Pennsylvania herds, twice daily for 15 d, both before and after UV light treatment (n = 60 samples per farm). All samples were analyzed for standard plate count (SPC), coliforms (C), non-coliform gram-negative bacteria (NC), environmental and contagious streptococci (ES and CS, respectively), coagulase-negative staphylococci (CNS), *Streptococcus agalactiae* (SAG), and *Staphylococcus aureus* (SA) count. Log reduction and percentage log reduction were calculated. Data were analyzed using the proc mixed procedure in SAS. UV light treatment significantly reduced all types of bacteria ($P < 0.001$). Weighted least squares means for log reductions (percentage log reduction) were 0.78 (23%), 1.06 (61%), 1.12 (42%), 1.38 (56%), 1.86 (93%), 1.09 (38%), and 1.24 (21%) for SPC, C, NC, ES, CS, CNS, and SA, respectively. Prior to UV light treatment 30% of samples had SPC <10,000 cfu/mL and 17%

of samples had C <10 cfu/mL. These percentages increased to 74% and 47% for SPC and C, respectively following treatment with UV light. A percentage log reduction of 50% has been suggested as a goal for calf milk pasteurization and has been shown to be achievable with heat pasteurization. Others have suggested maximum bacterial counts of 10,000 cfu/mL for SPC, 5,000 cfu/mL for ES, CS, and NC, and <10 cfu/mL for C. A percentage log reduction of 50% was achieved in 3 of 7 bacteria types, and 116 samples (43%) contained bacterial levels within the suggested limits after UV light treatment. Overall results of this study suggest that UV light treatment is not an acceptable alternative to heat pasteurization systems for bacterial inactivation in milk for use in calf feeding.

Key Words: ultraviolet light, milk, calf health

26 Fatty acid profile differs between organic and conventionally produced milk independently of sampling time. B. H. Schwendel*[1], P. C. H. Morel[2], T. J. Wester[2], M. H. Tavendale[1], C. Deadman[3], B. Fong[3], N. M. Shadbolt[2], A. Thatcher[2], and D. E. Otter[1], *[1]Food Nutrition & Health Team, Food & Bio-based Products Group, AgResearch Grasslands, Palmerston North, New Zealand, [2]Animal Nutrition Group, Institute of Veterinary, Animal and Biomedical Sciences, Massey University, Palmerston North, New Zealand, [3]Fonterra Research Centre, Palmerston North, New Zealand.*

Many differences reported in fatty acid (FA) composition between organic and conventionally produced cow's milk can be explained by the differing amounts of fresh forage and concentrates fed in the 2 systems. Comparisons in most previous studies were made between grazed organic cows and housed conventional cows. Our study investigated differences between organic and conventional milk produced using year-round pasture grazing utilized in New Zealand for both systems. FA composition was measured in milk sampled on 4 occasions during morning and evening milking in spring and autumn. Samples were taken from 24 cows selected randomly from the Massey University organic herd and compared with 26 cows from the corresponding conventional herd grazed and managed similarly at the same location. Thirteen out of 25 analyzed FA were influenced by season ($P < 0.001$), while one-third of the FA were different due to time of milking ($P < 0.001$). In addition, one-third were also different between production systems ($P < 0.001$). Variation observed in FA is illustrated using selected polyunsaturated FA. For example, linoleic acid (LA) and α-linolenic acid (ALA) were greater in organic milk while conjugated linoleic acid (CLA) and docosahexaenoic acid (DHA) were greater in conventional milk ($P < 0.001$; Table 1). Also, an interaction between system and milking time was observed for docosapentaenoic acid (DPA) and LA, where levels were greatest in conventional milk in the evening and were lowest in organic milk in the morning ($P < 0.005$). Our results confirm widely described reports that FA profile is affected by sampling time, however, we also showed an effect due to production system, even when cows are kept on pasture continuously.

Table 1. Effect of system, stage of lactation, and time on selected fatty acids

Fatty acid	System		Season		Time				
(g/100g)	Conventional	Organic	Spring	Autumn	am	pm	System	Season	Time
LA	0.81	0.92	0.72	1.01	0.87	0.86	***	***	NS
ALA	0.94	1.11	0.91	1.13	1.02	1.02	***	***	NS
CLA	1.55	0.93	1.01	1.47	1.18	1.30	***	***	*
DPA	0.14	0.14	0.12	0.16	0.13	0.14	NS	***	**
DHA	0.31	0.24	0.25	0.29	0.27	0.28	***	*	***

***$P < 0.001$, **$P < 0.01$, *$P < 0.05$, NS $P > 0.05$.

Key Words: milk, organic, fatty acid

27 An in vitro assessment of the antibacterial effects of plant essential oils. K. A. E. Mullen*, A. R. Lee, R. L. Lyman, S. P. Washburn, and K. L. Anderson, *North Carolina State University, Raleigh.*

In the growing organic dairy industry, there is need for non-antibiotic treatments for mastitis. Plant essential oils have anecdotal efficacy for treatment of mastitis in dairy cattle. The potential mechanism of action of essential oils in mastitis therapy has not been well studied. The objective of the current study was to evaluate the antibacterial activity of the essential oil components of Phyto-Mast, an herbal intramammary mastitis treatment, against 3 mastitis-causing pathogens (*Staphylococcus aureus*, *Streptococcus uberis*, and *Staphylococcus chromogenes*). The essential oils evaluated were *Thymus vulgaris*, *Gaultheria procumbens*, *Glycyrrhiza uralensis*, *Angelica sinensis*, and *Angelica dahuricae*. Broth dilution testing according to CLSI standard protocol was performed using ultra-pasteurized whole milk. Controls included milk only (negative control), milk + bacteria, and milk + penicillin-streptomycin (positive control, at 1 and 5% dilutions). Essential oil of *T. vulgaris* was tested by itself and not in combination with other oils because of its known antibacterial activity. The other essential oils were tested alone and in combination for a total of 15 treatments, each replicated 3 times and tested at 4, 2, 1, and 0.5% to simulate concentrations achievable in the pre-dry off udder quarter. Of all the individual essential oils tested, only *T. vulgaris* oil had consistent antibacterial activity against all 3 pathogens tested, and activity was seen at or above 2%. *T. vulgaris* essential oil completely inhibited bacterial growth in all replications of 2% or greater concentration. Though the combinations of oils did not show typical dose-response effects, some concentration levels were consistently antibacterial across all 3 replications. Our results indicate that only *T. vulgaris* essential oil has consistent antibacterial activity. Further evaluation of the physiological effects of essential oils on mammary tissue is recommended.

Key Words: essential oil, mastitis, antibacterial

28 Low doses of recombinant bovine somatotropin (rbST) enhance fertility of dairy cows. E. S. Ribeiro*[1], R. G. S. Bruno[2], A. M. Farias[2], J. A. Hernandez-Rivera[2], G. C. Gomes[1], R. Surjus[1], G. Sasser[3], D. H. Keisler[4], W. W. Thatcher[1], T. R. Bilby[2], and J. E. P. Santos[1], *[1]Department of Animal Sciences, University of Florida, Gainesville, [2]Texas A&M AgriLife Research and Extension, Stephenville, [3]BioTracking LLC, Moscow, ID, [4]Department of Animal Sciences, University of Missouri, Columbia.*

Objectives were to evaluate the effects of a single or 2 low doses of rbST on plasma hormone concentrations and fertility in dairy cows. Lactating Jersey and crossbred cows (n = 1,493) from 2 farms were inseminated for first AI postpartum on estrus. On the day of AI (study d 0), cows were blocked by parity and assigned randomly to receive a single placebo injection at AI (control), a single treatment injection with 325 mg of rbST at AI (S-bST), or 2 treatment injections with 325 mg of rbST administered at AI and 14 d later (T-bST). Blood was collected twice weekly and plasma analyzed for concentrations of GH, IGF-1, insulin, progesterone, and pregnancy-specific protein B (PSPB). Pregnancy was diagnosed on d 31 and 66. Ultrasonographic morphometry of conceptuses were performed on d 34 and 48. Data were analyzed using PROC GLIMMIX of SAS according to data distribution. Treatment with bST increased plasma concentrations of GH (control: 3.5 vs. S-bST: 6.4 vs. T-bST: 7.6 ng/mL; $P < 0.01$) and IGF-1 (control: 64.1 vs. S-bST: 77.4 vs. T-bST: 98.5 ng/mL; $P < 0.01$) from d 3 to 31, and increments were extended in T-bST. Treatments did not affect concentrations of insulin, progesterone and PSPB. However, a distinction in plasma PSPB between pregnant and non-pregnant cows ($P < 0.01$) occurred earlier for bST-treated cows (on d 21) than for controls

(on d 24). Pregnancy per AI, amniotic vesicle and embryo/fetus sizes were all increased by T-bST compared with control and S-bST (Table). In conclusion, administration of 325 mg of bST on d 0 and 14 relative to AI increased concentrations of GH and IGF-1, enhanced conceptus size, and improved fertility of dairy cows.

Table 1. Effect of bST treatments on fertility and conceptus morphometry

Item	Treatment			*P*-value
	Control	S-bST	T-bST	
Pregnant, %				
d 31	35.6^{b}	37.5^{ab}	43.1^{a}	0.08
d 66	29.9^{b}	29.2^{b}	38.0^{a}	0.01
Pregnancy loss, %	12.6^{ab}	19.1^{a}	8.6^{b}	0.04
Amniotic vesicle length, mm				<0.01
d 34	12.5±0.6^{B}	12.5±0.6^{B}	13.9±0.6^{A}	
d 48	29.3±0.8^{b}	28.5±0.8^{b}	31.8±0.8^{a}	
Embryo/fetus crown-rump length, mm				<0.01
d 34	10.6±0.5^{B}	10.5±0.6^{B}	12.0±0.6^{A}	
d 48	23.6±0.8^{b}	22.5±0.8^{b}	26.1±0.8^{a}	

Different superscripts within row: $^{a,b}P < 0.05$, $^{A,B}P < 0.10$.

Key Words: bST, dairy cow, fertility

29 Individual cow risk factors for development of ketosis in lactating dairy cattle. J. L. Gordon*[1], T. F. Duffield[1], T. H. Herdt[2], D. F. Kelton[1], and S. J. LeBlanc[1], *[1]University of Guelph, Guelph, ON, Canada, [2]Michigan State University, East Lansing.*

The purpose of this study was to determine risk factors at the cow level that lead to ketosis. Records from cows in 5 herds enrolled in 3 field trials on subclinical ketosis treatment were collected for evaluation. In all trials, study herds were visited once a week and cows between 3 and 16 DIM that had not been previously diagnosed with ketosis or a displaced abomasum or enrolled in the study were tested for blood β-hydroxybutyrate (BHBA) concentration using an electronic hand-held meter (Precision Xtra; Abbott). Electronic records were also collected at each visit. Information on previous lactation days carried calf (DCC), days dry (DDRY), days open (DOPN) and milk yield, as well as current parity was available for 1414 multiparous cows. DDRY was categorized into normal (30–60 d) long (>60 d) and short (<30 d) and parity as 2 or ≥3. Ketosis was defined as ≥ 1.2 mmol/L BHBA in whole blood using the Precision Xtra. Ketosis incidence was 35% overall, with incidence in Herd A at 15%, Herd B 30%, Herd C 32%, Herd D 38%, and Herd E 39%. Previous lactation total milk and 305ME had no effect on ketosis risk (P = 0.7–0.9), whether expressed as an absolute value or deviation from herd average. DDRY category also had no effect on ketosis risk (P = 0.3–0.8). DCC and DOPN were significantly associated with ketosis risk, controlling for herd and parity. An increase of 21 DOPN and a decrease of 10 DCC increased the odds of ketosis 1.3 (1.1–1.6, P = 0.003) and 1.2 (1.1–1.4, P = 0.01) times respectively. Controlling for parity, DOPN, and DCC, there were differences between herds in ketosis risk. In 1 herd, the trial was performed 2 years in a row and 334 cows were tested both years. Being diagnosed with ketosis the first year increased the odds of ketosis the second year by 2.2 times (1.4–3.4, P = 0.001) in this herd. There were no interactions between the risk factors. Herd, and ketosis and time to pregnancy in the previous lactation are associated with ketosis risk in lactating dairy cattle.

Key Words: ketosis, risk factor

30 Postnatal changes in gut bacteria and mucosal immune system development in dairy calves. N. Malmuthuge*[1], G. Liang[1], T. B. McFadden[3], P. J. Griebel[2], and L. L. Guan[1], *[1]Department of Agricultural, Food and Nutritional Science, University of Alberta, Edmonton, AB, Canada, [2]Vaccine and Infectious Disease Organization, Univ. of Saskatchewan, Saskatoon, SK, Canada, [3]Divison of Animal Sciences, University of Missouri, Columbia.*

Gut microbial establishment plays a vital role in development of the host mucosal immune system. However, there is limited knowledge on how postnatal establishment of the gut microbiome influences development of mucosal immune responses in dairy calves. This study investigated the relationship between the gut bacteria and mucosal immune responses over time. Small intestinal (mid jejunum, distal jejunum, ileum) tissue and digesta samples were collected from d 0 (n = 3), 1 (n = 6), 3 (n = 6) and 6 (n = 6) week old calves and quantified total bacteria, *Lactobacillus* and *Bifidobacterium* sp. as well as mucosal expression of bovine toll-like receptors (TLR), and immune-regulatory genes. Multivariate ANOVA of bacterial population and gene expression data revealed that calf age exerts a joint effect on bacterial density and mucosal immune responses. Total bacterial density in the small intestine of 6-wk-old calves (4.0 ± 2.0 × 10^{10} copies of 16S rRNA gene) was significantly higher than that of d 0 calves (7.3 ± 2.0 × 10^{8} copies/g). The prevalence of *Lactobacillus* sp. was lower in d 0 and 6-wk-old calves (>1%) compared with 1-wk (7.1%) and 3-wk (5.7%) old calves. In contrast, *Bifidobacterium* were prevalent than *Lactobacillus* at all ages with peak prevalence (21.2%) observed in 3-wk-old calves. Expression of TLR 1 to 10, except TLR9, was age dependent and expression of most TLRs was lowest in d 0 calves. Strong correlations were observed between total bacterial density and TLR expression levels but these associations varied with age. Mucosal expression of IL8 and IL10 was significantly higher in 1 and 3-week-old calves compared with d 0 and 6-week-old calves and cytokines expression was positively correlated with *Lactobacillus* and *Bifidobacterium* populations but not with total bacteria, signifying these specific bacterial species may associate with postnatal mucosal immune regulation. The present study revealed that gut bacterial density and mucosal immune system change significantly within the first weeks of life and changes in gut bacteria may influence the immune development during the early life of dairy calves.

Key Words: gastrointestinal tract, bacteria, mucosal immunity

31 Management of dairy goats during the transition between lactations. G. Zobel*[1], K. Leslie[2], D. M. Weary[1], and M. A. G. von Keyserlingk[1], *[1]Animal Welfare Program, University of British Columbia, Vancouver, BC, Canada, [2]Population Medicine, University of Guelph, Guelph, ON, Canada.*

Dry-off and the onset of the new lactation are key periods of risk for intramammary infections, but little work to date has examined how management of this transition affects dairy goat health and welfare. To guide such research, it is helpful to describe management practices currently employed. The aim of this study was to determine the practices of dairy goat milk producers in Ontario, Canada. The survey was sent by mail to all 229 licensed farms of which 67 responded (i.e., response rate of 29%). Analyses are descriptive and all results are presented as means ± SD. On average, farms milked 203 ± 125 goats, with an average lactation length of 330 ± 99 d (1st lactation) and 386 ± 168 d (2+ lactations). The most common breeds were Saanen (66 ± 25%) and Alpine (28 ± 21%). The majority of producers (79%) ranked days until kidding and milk production as their top deciding factors when choosing to drying-off their goats; interestingly, 83% had no ability to record individual milk production. Furthermore, although the average

dry period cited was 53 ± 11 d, nearly 20% of the farms noted that does are occasionally milked for over 600 d, regardless of pregnancy status. They cited the top reasons for skipping a dry period as persistent milk production, even when pregnant (71%) and continuing to milk because the doe had not been bred in the current year (17%). Two respondents indicated that they did not dry-off their goats at all. To induce dry-off, 40% of producers reported restricting access to feed, while water restriction was used on 4 of the farms. Interestingly, not all producers felt diet had a major effect on dry-off, with 26% reporting no change in feeding practices. Intramammary antibiotic and teat sealer use was minimal (17% and 2%, respectively) despite producers expressing that they were "moderately or extremely concerned" about subclinical and clinical mastitis (28% and 35%, respectively). These results suggest the need for research to determine the effects of the large variety of dry-off methods being used by producers, including extended lactations and skipped dry periods in dairy goats.

Key Words: does, dry-off, udder health