test period when using this function. Based on analysis of residual patterns, the Bridges, Gompertz, and exponential second order polynomial functions were more sensitive to violation of the assumption of constant residual variance across time. The least amount of bias in the representation of the growth patterns of pigs was observed when using a random regression procedure and a second order polynomial function.

Key Words: Swine, Growth, Function

917 Processing of western Canadian feed ingredients improves their digestibility in Nile tilapia *(Oreochromis niloticus)*. T. L. Borgeson*, D. L. Thiessen, V. J. Racz, and M. D. Drew, *University of Saskatchewan, Saskatoon, SK, Canada*.

The apparent digestibility coefficients (ADC) of unprocessed and processed pea, canola and flax products were determined on diets, in which 30% of a reference diet was replaced by each test ingredient. Celite was used as an indigestible marker for measuring apparent digestibility coefficients indirectly. The trial was conducted in a semi-closed recirculating system using 5 tanks per diet with 40 fish per tank, and feces were collected using a settling column. The processed ingredients included dehulled flax produced by abrasive dehulling, canola protein concentrate and pea protein concentrate, which were produced by aqueous extraction of peas and canola meal, respectively. Coextrudates of canola and peas (C:P) or flax and peas (F:P) were also tested. Processing had no significant effect on the ADC of crude protein except for flax. Whole flax had negative ADC for crude protein, energy and dry matter probably due to the high viscosity of this diet. Processing significantly improved the ADC of energy and dry matter for pea, canola meal and flax ($P < 0.05$). The ADC for crude protein for C:P was not significantly different than pea or canola meal while the ADC for crude protein for F:P was intermediate between flax and pea. The coextruded products had ADC for energy and dry matter that were significantly higher than those of the component ingredients ($P < 0.05$). The results suggest that these processing methods can significantly improve energy and dry matter ADC of pea, canola and flax by tilapia but have less effect on protein digestibility.

Ingredient	Crude protein	Energy	Dry Matter
Pea	0.86^{a}	0.58^{cd}	0.59^{cde}
Pea protein concentrate	0.95^{a}	0.95^{a}	0.93^{a}
Canola meal	0.82^{a}	0.68^{bc}	0.54^{de}
Canola protein concentrate	0.86^{a}	0.84^{ab}	0.78^{abc}
Extruded canola:pea	0.76^{ab}	0.84^{a}	0.69^{bcd}
Whole flax	-0.38^{d}	-0.27^{e}	-0.45^{f}
Dehulled flax	0.46^{c}	0.48^{d}	0.41^{e}
Extruded flax:pea	0.61^{b}	0.53^{cd}	0.41^{e}

$^{a\text{-}f}P < 0.05$ within columns.

Key Words: Feed processing, Digestibility, Tilapia

Physiology and Endocrinology: Stress and Inflammation: Effects on Animal Performance

918 Performance of gilts housed individually in stalls or in groups in pens during the first 30 d post-mating. M. J. Estienne*, A. F. Harper, and J. W. Knight, *Virginia Polytechnic Institute and State University, Blacksburg*.

In the U.S. most sows are individually housed throughout gestation in stalls that allow only standing, sitting and lying. Use of gestation stalls is a contentious welfare issue that may lead to legislation limiting the housing of sows in stalls to a defined interval that is less than the total gestation period. The objective was to assess performance of gilts housed individually in stalls or in groups in pens for the first 30 d after mating. Gilts (n = 56; 159.5 ± 1.5 kg BW; 15.0 ± 0.5 mm backfat) were mated via AI twice during estrus. After the second AI, gilts were placed in stalls (0.6 × 2.0 m) (n = 14) or pens (1.7 × 3.1 m) containing three gilts each (n = 14), and were fed at a rate of 2 kg/gilt/d. Gilts housed in pens gained more BW than gilts housed in stalls (11.0 vs. 6.7 kg; SE = 0.8; P < 0.01), but change in backfat was similar between treatments (-0.3 vs. -0.4 mm; SE = 0.5; P = 0.80). The proportion of gilts exhibiting stereotypies on d 28 was not affected by treatment (81 for groups vs. 93% for stalls; SE = 7.2; P = 0.26). Wound scores (0 to 5; 5 = severe) were greater for group-housed gilts and were greatest during the first 7 d post-mating. For example, wound scores for the head, face and ears (2.5 vs. 1.3; SE = 0.2) and neck and shoulders (2.6 vs. 0.3; SE = 0.2) on d 3 were greater (P < 0.01) for group- vs. stall-housed gilts. Lameness scores (0 to 5; 5 = severe) on d 30 were greater in group- compared to stall-housed gilts (0.6 vs. 0.2; SE = 0.1; P = 0.06). Pregnancy rate at d 30 was lower (P < 0.01) for group- compared to stall-housed gilts (85.7 vs. 100%; SE = 3.2). Following slaughter at d 30 of gestation, the number of embryos (13.8 vs. 15.5; SE = 1.8; P = 0.51), embryo weight (1.59 vs. 1.58 g; SE = 0.07; P = 0.89) and crown-rump length (27.2 vs. 27.1 mm; SE = 0.46; P = 0.92) were similar for group- and stall-housed gilts, respectively. Indicators of welfare were differentially affected by type of gestation housing and pregnancy rate was maximized in gilts housed individually in stalls.

Key Words: Gestation, Housing, Gilt

919 Effects of stress and genotype on immune and cortisol measures in pigs. M. A. Sutherland*, S. R. Niekamp, S. L. Rodriguez-Zas, and J. L. Salak-Johnson, *University of Illinois, Urbana*.

Pigs are exposed to many stressors during common management and production practices. Genotypic differences in immune measures and cortisol concentration in pigs have been reported but the influence of genotype on stress responsiveness is limited. The objective of this experiment was to determine the effect of "breed" and commercial genotypes on immune and cortisol responses in pigs subjected to multiple stressors over 14 d. Piglets from Landrace Cross (n=36), Meishan (n=30), Yorkshire (n=32) and two commercial lines (LineA and LineB; n=36) were weaned at 17 to 21 d and kept in a common nursery environment. At 6 wk of age pigs were assigned either no stress (control) or stress (heat, crowding, mixing) treatment. Blood samples were obtained via veni-puncture at d 0 (baseline), 1, 7 and 14 post-stress to determine white blood cell counts, differentials, cortisol (CORT), IgG, lymphocyte proliferation (LPA), natural killer cytotoxicity (NK), phagocytosis and antibody response to sheep red blood cells. There were significant genotype and genotype x day interaction effects for CORT and numerous immune measures. CORT levels were lower (P < 0.0001) in stressed pigs compared to controls. At d 7, CORT levels were lower (P < 0.05) in stressed Meishans and Yorkshires compared to controls and remained suppressed in Meishans until d 14 (P < 0.01). LPA response was higher (P < 0.05) in stressed Meishans at d 1, and remained elevated until d 14, compared to control pigs (P < 0.05). NK, at E:T ratio of 25:1, was higher (P < 0.05) in Landraces and Yorkshires at d 14 compared to control pigs. In commercial lines, CORT levels were lower (P < 0.05) in stressed pigs compared to their controls at d 7. LPA response was higher (P < 0.01) in stressed LineA pigs at d 1 compared to control pigs. These results indicate a genotype effect on immune and cortisol concentrations in response to stress and that these effects change over time.

Key Words: Immune, Pigs, Genotype

920 The use of a Hens' Odorant Analogue to control stress consequences in Broilers. I. Madec*[1], J. F. Gabarrou[2], A. Bruneau[1], L. Bougrat[1], D. Saffray[1], B. Silliart[3], and P. Pageat[1], [1]*Pherosynthese, Saint Saturnin Apt, France,* [2]*Esa Purpan, Toulouse, France,* [3]*Env Nantes, Nantes, France*.

In poultry, stress has consequences such as pecking behavior, increased feed to gain ratio, high mortality or bad carcass quality. Indicators of stress include: high H/L (Heterophil/Lymphocyte) ratio and elevated corticosterone secretion. We have identified in the uropygial glands in laying hens a secretion (named HOA: Hens Odorant Analogue, under patent). To test the hypothesis that HOA has stress-preventive actions and improves general performance, a trial was conducted (HOA vs control) using two similar buildings, each housing 24,000 chickens. Chickens were maintained on the ground floor under similar conditions. Males were separated from females. The HOA was administered by passive diffusion in the building atmosphere (one diffuser for 1000 chickens). After treatment, HOA-treated animals were heavier than controls: 2.22

vs 2.06 ($p < 0.0001$) for males and 1.13 vs 1.09 ($p < 0.0001$) for females. Percentage of scratched animals was lower in the HOA treated group than in controls: 8% vs 22% ($p<0.001$) for males, 10% vs 19% ($p<0.001$) for females. Results concerning suffocated chickens were more ambiguous. Indeed there were more suffocated females in the control group: 6.36% vs 3.25% ($p < 0.001$), whereas there were more suffocated males in the HOA treated group: 1.36% vs 1.11% ($p < 0.05$). Treated animals had a lower H/L ratio: 0.81 vs 1.11 ($p<0.01$) for males, 0.77 vs 0.85 ($p<0.001$) for females. Corticosterone level was higher in the control group for males (3.40 vs 2.64, $p<0.05$) but not for females ($p > 0.05$). The observed differences between the two groups suggest that chickens treated with HOA are subject to less stress than control chickens. Conversely, the number of suffocated animals is generally related to physiological distress, which tends to show that HOA has no real influence on this phenomenon. Economic data indicated that the gross margin was higher for the treated building by 4.8%. Further studies are required to more clearly define the physiologic and economic impact of treating chickens with HOA.

Key Words: Stress, Broilers, Apeasing

921 Involvement of anterior pituitary arginine vasopressin receptor V3 in the stress response of cattle. M. Knights*[1], N. K. Ames[2], and G. W. Smith[2], [1]*Division of Animal and Veterinary Sciences, West Virginia University, Morgantown,* [2]*Departments of Large Animal Clinical Sciences, Michigan State University, East Lansing,* [3]*Departments of Animal and Physiology, Michigan State University, East Lansing.*

The stress-induced increase in ACTH and cortisol is stimulated by corticotropin releasing factor (CRF) and arginine vasopressin (AVP). Effects of CRF and AVP are mediated via their anterior pituitary (AP) receptors, CRFR1 and V3 respectively. In the present studies, we evaluated effect of the V3 receptor antagonist deamino-AVP (dAVP) on LPS-induced ACTH and cortisol secretion and AP abundance of CRFR1 and V3 mRNAs in cattle. In Study 1, Holstein steers received i.v. saline or dAVP (10 μg/kg), followed 1 h later by i.v. LPS (200 ng/kg) or saline ($n = 4$ per treatment). Previous studies demonstrated that dose of dAVP utilized effectively blocks AVP-induced ACTH and cortisol secretion in cattle. Blood samples were collected at time of LPS injection and 2 h later for determination of plasma ACTH and cortisol. ACTH and cortisol secretion were not affected by dAVP treatment alone. LPS increased ACTH secretion by 400% ($P < 0.001$) and the stimulatory effect of LPS was enhanced 200% by dAVP treatment ($P < 0.001$). A similar effect on cortisol secretion was observed, but the magnitude of increase was less. In Study 2, we determined effect of dAVP on LPS-induced changes in AP CRFR1 and V3 mRNA abundance. Intracerebroventricular (ICV) cannulated Holstein steers received either saline or ICV dAVP (750 μg) followed 1 h later by i.v. saline or LPS. At 4 h post LPS, steers were sacrificed and AP collected for RNA isolation. Relative concentrations of AP CRFR1 and V3 mRNAs (normalized relative to RPL-19 mRNA) were determined using quantitative real-time PCR procedures. LPS decreased ($P < 0.05$) abundance of CRFR1 and V3 mRNAs compared to saline (control), but effects of LPS were blocked by ICV dAVP administration. Results lead to the suggestion that AP V3 receptor signaling pathways inhibit LPS-induced ACTH and cortisol secretion and LPS-induced down regulation of AP CRFR1 and V3 mRNAs in cattle. Supported by USDA 2001-35204-10801 (GWS) and the MI Agricultural Experiment Station.

Key Words: V3 Receptor, Stress, Cattle

922 Plasma progesterone response to ACTH administration in the ewe during diestrus and following ovariectomy. R. W. Godfrey*[1], A. J. Weis[1], R. E. Dodson[1], M. Loewer[1], and S. T. Willard[2], [1]*University of the Virgin Islands,* [2]*Mississippi State University, Mississippi State.*

The role of the adrenal gland in reproduction has not been elucidated completely, yet has been suggested to be a significant source of progesterone (P4) in some species. The objective of this study was to evaluate the P4 response following ACTH administration in ewes synchronized to diestrus and in ewes following ovariectomy. Sixteen ewe lambs (27.0 $\pm$ 0.82 kg; 8.1 $\pm$ 0.04 mon of age) were synchronized using CIDRs, which were removed 12 d post-insertion. On d 11 post-CIDR withdrawal (diestrus), ewes received one of three treatments (i.v.): 1.0 IU ACTH ($n = 6$); 0.1 IU ACTH ($n = 5$); saline (control, no ACTH; $n = 5$). Blood samples (plasma) were collected at Time -15, 0 (infusion), 15, 30, 45, 60, 120, 240 and 480 min in relation to ACTH treatment. Ewes were then ovariectomized (OVEX) 11 weeks later and ACTH challenges repeated. Plasma P4 and cortisol (CT) were determined by RIA. Plasma CT for diestrus ewes peaked at 30 min post-ACTH treatment for the 1.0 and 0.1 IU ACTH groups, increasing 5.5 $\pm$ 0.8- and 2.6 $\pm$ 0.7-fold over pre-treatment values. Plasma CT for OVEX ewes peaked at 60 min post-ACTH treatment for the 1.0 IU ACTH group and at 30 min for the 0.1 IU ACTH group; increasing 15.1 $\pm$ 5.0- and 8.1 $\pm$ 2.8-fold over pre-treatment values respectively. Area under the ACTH response curves (AUC; 0 to 120 min) for plasma CT differed ($P < 0.05$) among treatment groups in a dose-dependent fashion for diestrus and OVEX ewes. In diestrus ewes plasma P4 increased over time ($P < 0.05$) for all groups, and AUC for P4 differed ($P < 0.05$) between the 1.0 IU versus 0.1 IU and control treatment groups. In OVEX ewes, P4 AUC differed ($P < 0.05$) in a dose-dependent fashion, peaking at 60 and 30 min post-ACTH for the 1.0 and 0.1 IU ACTH groups respectively. In summary, ACTH administration in diestrus and OVEX ewes resulted in a dose-dependent increase in CT, as expected. In diestrus ewes only a transient increase in P4 was noted (1.0 IU ACTH group), while in OVEX ewes a dose-dependent effect of ACTH on adrenal P4 production was observed. These data indicate variable responses in adrenal P4 secretion post-ACTH administration in diestrus versus OVEX ewes.

Key Words: ACTH, Progesterone, Adrenal

923 Plasma progesterone response to ACTH administration in the pregnant ewe during early and late stages of gestation. S. T. Willard*[1], A. J. Weis[2], R. E. Dodson[2], M. Loewer[2], and R. W. Godfrey[2], [1]*Mississippi State University,* [2]*University of the Virgin Islands.*

The adrenal gland has been suggested to contribute to the maintenance of pregnancy during times of acute stress through stimulation of adrenal progesterone (P4) production. However this has not been firmly established, nor has the secretion of P4 been characterized relative to stage of gestation in response to acute stimulation of adrenal function. The objective of this study was to evaluate the P4 response, above that of luteal/placental origin, following ACTH administration in ewes during early and late stages of gestation. Twenty pregnant St. Croix White ewes (49.7 $\pm$ 2.0 kg; 4.0 $\pm$ 0.4 yrs) were treated (i.v.) with one of the following: 1.0 IU ACTH ($n = 8$); 0.1 IU ACTH ($n = 6$); saline (control, no ACTH; $n = 6$) at 60 and 120 d of gestation. Blood samples (plasma) were collected at Time -15, 0 (infusion), 15, 30, 45, 60, 120, 240 and 480 min in relation to ACTH treatment. Plasma P4 and cortisol (CT) were determined by RIA. At 60 d of gestation, plasma CT peaked at 60 min post-ACTH treatment for the 1.0 IU ACTH group and at 30 min for the 0.1 IU ACTH group; increasing 13.0 $\pm$ 6.1- and 6.3 $\pm$ 1.3-fold over pre-treatment values. At 120 d of gestation, plasma CT peaked at 120 min post-ACTH treatment for the 1.0 IU ACTH group, and at 45-min for the 0.1 IU ACTH group; increasing 6.3 $\pm$ 1.5 and 9.7 $\pm$ 3.0-fold over pre-treatment values. Area under the ACTH response curves (AUC; 0 to 120 min) for plasma CT at 60 and 120 d of gestation differed ($P < 0.01$) among treatment groups in a dose-dependent fashion, while AUC for P4 did not differ ($P > 0.10$) among treatment groups. Plasma P4 increased over time ($P < 0.05$) throughout the day of challenge for all groups at 60 and 120 d of gestation, but did not differ ($P > 0.10$) relative to ACTH treatment. In summary for ewes during early and late gestation, ACTH administration resulted in a dose-dependent increase in CT, as expected. However, ACTH administration did not increase plasma P4 above that of pre-treatment baseline (luteal/placental) concentrations. These data indicate that ACTH administration does not result in a supplemental rise in adrenal P4 during early and late gestation in the pregnant ewe.

Key Words: ACTH, Progesterone, Gestation

924 Effects of temperament on stress indicators in Brahman heifers. K. O. Curley, Jr.*[1,2], D. A. Neuendorff[2], A. W. Lewis[2], J. J. Cleere[2], T. H. Welsh, Jr.[1], and R. D. Randel[2], [1]*Texas Agricultural Experiment Station, College Station,* [2]*Texas Agricultural Experiment Station, Overton.*

The objective of this study was to compare adrenal responsiveness to pituitary stimulation with exogenous CRH in calm (C) and temperamental (T) heifers. The C and T groups (selected using exit velocity (EV) from a squeeze chute) consisted of the 6 slowest (EV=1.05$\pm$.05 m/sec) and 6 fastest (EV=3.14$\pm$0.22 m/sec) 2-year old Brahman heifers in the herd.

Blood samples were collected via indwelling jugular cannulas (fitted ∼18h prior) for a period of 6h pre- and 6h post- administration of CRH (0.1 μg/kg BW). Sampling intervals were 15min throughout the 12h except for the initial 30min and final 180min of the post-challenge period; where the sampling intervals were 5 and 30min, respectively. Serum cortisol (CS) concentrations were determined via RIA. Pearson correlation coefficients and ANOVA were used for statistical comparisons. Basal CS, determined as the mean concentration (ng/mL) within the 1h period prior to CRH challenge, was highly correlated to EV (r=.90; P<.001) and differed (P<.001) between temperament groups (C=10.07±2.3 and T=38.66±3.7). Following CRH challenge, both peak CS and time to reach peak CS did not differ between temperament groups. However, temperament did influence (P=.01) the increase, induced by the CRH challenge, from basal CS (C=753±220 and T=124±47%). A negative correlation was found between EV and % increase in CS (r=-.63; P<.03). Time to return to basal CS was also influenced (P<.04) by temperament group as C took longer than T heifers (C=267±14 and T=152±44min). The area under the curve following the return to basal CS was also influenced (P<.01) by temperament (C=9222±616 and T=14973±1568 ng*min/mL), indicating that the CS concentrations in the T heifers remained higher than C heifers. As poor temperament relates to increased basal adrenal activity and muted responsiveness to pituitary stimulus, temperament does affect stress mechanisms. Exit velocity can be used as an indicator of temperament and an indicator of pituitary-adrenal function.

Key Words: Temperament, CRH Challenge, Exit Velocity

925 Administration of exogenous prolactin (PRL) to steers on short day photoperiod: effects on PRL, PRL-receptor (PRL-R) expression, and immune function.

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Photoperiod management significantly affects physiology of dairy cattle. For example, long day photoperiod (LDPP) during lactation increases milk yield, whereas short day photoperiod (SDPP) during the dry period increases milk production in the subsequent lactation. We have also observed an improvement in cellular immune function in animals on SDPP relative to their LDPP counterparts. In addition, PRL sensitivity is altered by photoperiod management. Our hypothesis is that the inverse relationship observed between PRL and PRL-R mRNA expression during photoperiod treatment alters the sensitivity of the animal to PRL, thereby affecting the changes in their cellular immune function. The objectives of this study were to supply exogenous PRL to in vivo and in vitro models to determine the effects of PRL on photoperiodic mediated immune responses. Eight Holstein steers received each of four treatments: LDPP (16 h light:8 h dark), SDPP (8 h light:16 h dark), SDom (SDPP plus PRL via osmotic minipump for 10 d), and SDinj (SDPP plus PRL via 3x daily injections for 10 d). Solutions of PRL were formulated so that animals received 4.0 mg/d PRL with 0.9% saline. Steers on SDPP had decreased PRL concentrations ($P < 0.05$) relative to the other three treatments. Expression of long form PRL-R mRNA on lymphocytes was increased in SDPP treated animals relative to LDPP, SDom, and SDinj. Prior to PRL treatment, SDPP animals had greater lymphocyte proliferation and neutrophil chemotaxis ($P < 0.01$) relative to LDPP animals. However, following PRL treatment, lymphocyte proliferation and neutrophil chemotaxis of SDom and SDinj animals were reduced to the level of LDPP animals. Addition of PRL to the in vitro lymphocyte proliferation increased proliferation of lymphocytes from SDPP animals but did not alter response of LDPP animals. These results support the concept that an animals altered PRL sensitivity mediates the changes in cellular immune function observed with photoperiod manipulation.

Key Words: Prolactin, Photoperiod, Immune Function

926 Characterization of changes in hepatic expression of inflammation-associated genes during the peripartum period in multiparous Holstein cows using quantitative real time-PCR (RT-PCR).

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Dietary strategies in the dry period and early lactation might impact hepatic expression of genes associated with inflammatory responses, which in turn could impact metabolic adaptations to lactation. The objective of this study was to characterize changes in hepatic expression of tumor necrosis factor-α (TNF-α), peroxisome proliferator activated receptor-γ (PPAR-γ), PPAR-α, and interleukin-6 (IL-6) during the dry period through 49 DIM in cows fed according to current NRC recommendations. Five multiparous Holstein cows had ad libitum access to a far-off dry period diet (1.29 Mcal NE_l/kg; 15.8% CP) from d -65 through -25 relative to parturition, followed by ad libitum access to a close-up diet (1.61 Mcal NE_l/kg; 15.7% CP) from d -24 until parturition. Cows were fed a common lactation diet (1.77 Mcal NE_l/kg; 18.1% CP) from 1 through 49 DIM. Liver biopsies were collected on d -65, -30, -14, +1, +14, +28, and +49 relative to calving and RNA was extracted with Trizol reagent. Complementary DNA was made from 2 μg of total RNA and primers for RT-PCR were designed to yield amplicons #8804100 bp. Relative copy number in PCR amplifications was measured using SYBRGreen I Dye fluorescence. Bovine 18S rRNA was used as an internal standard for data normalization. Day -65 relative to parturition was used as a baseline to compare relative changes in expression. Relative to d -65, preliminary analysis of data using all cows showed that relative copy number of TNF-α was 1.85-fold greater ($P = .05$) on d + 1 relative to calving. Fold changes on d -14 and +14 were 1.11 and 1.57 compared to d -65 ($P > .17$). Relative to d -65, fold changes in relative copy number of PPAR-γ were 1.36, 1.94, or 1.83 on d -14, +1, and +14, respectively ($P > .36$). Results showing increases in relative copy number for these two genes suggest that inflammatory or general stress responses occurred in the liver after parturition.

Key Words: Real Time-PCR, Hepatic Genes, Periparturient Period

927 Effect of estrus and pregnancy status on growth hormone receptor and IGF-I gene expression in the uterus and liver of postpartum dairy cows.

M. L. Rhoads*, J. P. Meyer, W. R. Lamberson, D. H. Keisler, and M. C. Lucy, *University of Missouri, Columbia*.

Growth hormone (GH), the GH receptor (GHR) and IGF-I are thought to play critical roles during early pregnancy in dairy cattle. The objective of this study was to measure total GHR (tGHR) and IGF-I mRNA in liver and uterine (endometrial) tissue around the time of artificial insemination at four stages of lactation (1=46 ± 4 d, n=5; 2=80 ± 3 d, n=11; 3=122 ± 3 d, n=10; 4=160 ± 3 d, n=8). Estrus was synchronized with $PGF_{2\alpha}$ and cows were inseminated 12 h after estrus. Uterine biopsies were collected at the $PGF_{2\alpha}$ injection (before estrus, BE), at the initiation of estrus (E) and 4 d after estrus (AE). Liver was biopsied AE. The amount of tGHR and IGF-I mRNA in liver and uterus was analyzed by real-time quantitative PCR. tGHR mRNA and IGF-I mRNA were correlated in liver (r=0.64, P<0.01) and uterus (r=0.85, P<0.01) but neither mRNA were affected by stage of lactation. The amount of liver IGF-I mRNA (r=0.67, P<0.01) but not uterine IGF-I mRNA (P>0.10) was positively correlated with plasma IGF-I concentrations. The conception rates for stages 1, 2, 3 and 4 were 80, 55, 50 and 25%, respectively. There was an effect of pregnancy status on liver tGHR mRNA because cows that became pregnant had more tGHR mRNA than non-pregnant cows (41.8 ± 3.2 and 27.4 ± 3.8 AU, respectively; P<0.01). There was no effect of pregnancy status or stage on uterine tGHR or IGF-I mRNA. There was an effect of day of the estrous cycle because uterine tGHR mRNA (eight-fold increase over BE; P<0.05), uterine IGF-I mRNA (five-fold increase over BE; P<0.01) and plasma IGF-I were highest at estrus. In summary, uterine IGF-I gene expression was correlated with tGHR mRNA. Both tGHR and IGF-I mRNA increased in uterine tissue at estrus, a time when blood IGF-I concentrations were also greatest. Cows that became pregnant had similar uterine mRNA but higher liver tGHR mRNA. These data fail to implicate uterine mRNA in the establishment of pregnancy but instead suggest that liver tGHR is greater in early pregnancy.

Key Words: Growth Hormone Receptor, IGF-I, Uterus

928 Assessments of udder temperature gradients pre- and post-milking relative to milk production in Holstein cows as determined by digital infrared thermography.

S. Schmidt*, S. Bowers, T. Dickerson, K. Graves, and S. Willard, *Mississippi State University, Mississippi State*.

Digital infrared thermal imaging (DITI) is a non-invasive diagnostic technique that can be used to measure symmetry and/or asymmetry of surface temperature gradients associated with physiological phenomenon. In the present study, thermal images were acquired from lactating Holstein cows (n = 16) to assess temperature gradients of the

mammary gland in high (n = 8; 18.5 ± 1.5 kg milk, 182.9 ± 6.75 DIM) and low (n = 8; 14.9 ± 1.3 kg milk, 182.8 ± 6.7 DIM) milk producers (MP). Three thermal images (left-fore, right-fore and rear udder) were acquired for each cow pre- and post-milking at bimonthly intervals over a period of 3 months (6 measurement periods). Rectangular transects were drawn on thermal images to quantify temperature gradients of the udder, and temperatures (°C) were expressed as MAX, AVG, MIN and standard deviation (SD) within transect areas. Udder volume (UV) measurements were collected at the time of imaging pre- and post-milking. No differences ($P > 0.10$) were observed in UV for high versus low MP throughout the study. Overall, MAX and AVG udder and teat temperatures were greater ($P < 0.001$) pre-milking than post-milking, as were MIN teat temperatures ($P < 0.01$). Udder temperatures also differed ($P < 0.01$) by udder quarter pre- and post-milking, while teat temperatures by quarter did not differ ($P > 0.10$) pre- or post-milking. High MP had greater ($P < 0.01$) udder temperatures than low MP (MAX, AVG, MIN) pre- and post-milking (AVG: High Pre, 34.8 ± 0.07 °C; High Post 34.6 ± 0.08 °C; Low Pre: 34.07 ± 0.09 °C, Low Post 33.7 ± 0.09 °C), while teat temperatures did not differ ($P > 0.10$) relative to level of milk production. Temperature SD within transect areas did not differ ($P > 0.10$) pre- or post-milking for udder quarter or teat, indicating uniformity of temperature measurements within transects. In summary, high MP had greater udder temperatures pre- and post-milking than low MP. These data suggest that DITI may have value as a diagnostic tool for assessing udder function in relation to temperature gradient changes and level of milk production.

Key Words: Udder, Thermography, Milk Production

929 Heat dissipation in winter-acclimated lactating cows and non-lactating heifers subjected to increased ambient temperature and solar radiation in Arizona. B. C. Pollard*, E. A. Annen, L. H. Baumgard, R. C. Cheatham, M. D. Estheimer, M. E. Dwyer, A. C. Fitzgerald, H. C. Halfliger, C. E. Moore, J. K. Kay, O. B. Mendivil, P. C. Gentry, D. A. Henderson, C. M. Steining, and R. J. Collier, *The University of Arizona, Tucson*.

Heat dissipation responses of dairy cattle to heat stress are poorly understood. The objective of this study was to compare total evaporative water loss (TEWL) in winter-acclimated lactating cows vs. non-lactating heifers, under three environmental conditions. Six lactating cows (DIM 60-110) and six pregnant, non-lactating heifers (150 d pregnant) were assigned randomly to bST (Posilac®, Monsanto Co., St. Louis, MO) or no bST. Beginning January 21, 2004, animals were housed in two environmental rooms (n=6/room) with temperature, solar radiation, humidity and day length (18 h light:6 h dark) control. The study was divided into two phases of 14 d each. In phase 1, room 1 was held at thermoneutral (TN; temp. range=8.4-17.0°C) while room 2 was programmed to provide heat stress (HS; temp. range=27.8-38.9°C). In phase 2, cows in room 1 were treated to HS plus 4 h of solar radiation (HS+S; 600 Wh/m^2) while room 2 remained at TN conditions. After 1 wk, heat dissipation was determined by TEWL from the loin and rump of both left and right sides (Vapometer®, Delfin Technologies, Finland). Overall, TEWL was greater ($P < 0.05$) in cows vs. heifers in all environmental conditions. Average TEWL was increased in HS and HS+S over TN ($P < 0.001$), and TEWL was higher in lactating cows compared heifers in HS and HS+S ($P < 0.001$). These results demonstrate that cows increase their insensible heat dissipation in order to cope with the increased heat load from both milk production and increased environmental heat stress.

Key Words: Heat Stress, Dairy Cattle, Solar Radiation

930 Hepatic gene expression profiling in lactating dairy cows during an initial period of hyperthermia. R. P. Rhoads*[1], J. D. Sampson[1], R. J. Tempelman[2], S. S. Sipkovsky[2], P. M. Coussens[2], M. C. Lucy[1], J. N. Spain[1], and D. E. Spiers[1], [1]*University of Missouri, Columbia,* [2]*Michigan State University, East Lansing*.

Environmentally-induced hyperthermia in lactating dairy cows depresses milk production as a consequence of whole body adaptations involving shifts in metabolism and a reduction in feed intake. In this context, the liver is uniquely positioned to direct exogenously and endogenously-derived nutrients for use by other metabolically active tissues such as the mammary gland. Despite the prominent role of the liver in whole-body metabolism, changes in the molecular mechanisms leading to hepatic adaptation during heat challenge are unclear in the dairy cow. Therefore, the objective of this study was to characterize the gene expression profile of hepatic tissue in dairy cows undergoing a transition from thermoneutral (TN) to heat stress (HS) conditions. Six Holstein dairy cows (61 ± 8 d postpartum) were acclimated to TN conditions (19° C) for 1 wk prior to exposure to HS conditions (29° C). Rectal temperature (Tre) and respiration rate (RR) were measured at 4 h intervals during both periods. Total RNA from liver biopsies obtained on d 4 of the TN period (n=6) and then at 24 (n=2), 48 (n=2) and 96 (n=2) h of the HS challenge was reverse transcribed to cDNA. TN and HS paired samples were sequentially labeled with Cy3 or Cy5 prior to hybridization to a bovine-specific NBFGC microarray containing 18,263 unique ESTs. Reversal of the dye direction between paired samples was used to account for possible dye bias. Gene expression data were normalized and analyzed using a two-stage mixed effects model in SAS. The transition from TN to HS increased Tre (39.0° vs 40.3° C, $P<0.01$) and RR (62 vs 86 breaths per minute, $P<0.01$). Preliminary analysis indicates that hyperthermia induced the differential expression of at least 20 genes ($P<0.001$) with a similar number of up and down-regulated genes. In conclusion, the imposed heat stress was sufficient to alter liver gene expression that may be important in the hepatic adaptation to heat challenge.

Key Words: Liver, Microarray, Hyperthermia

931 Exposure to endotoxin during estrus or corpus luteum formation impaired reproductive functions in cows. Y. Lavon[1], G. Leitner[2], T. Goshen[1], M. Hogeg[1], R. Braw-Tal[3], M. Maman[1], S. Jacoby[3], and D. Wolfenson*[1], [1]*The Hebrew University, Rehovot, Israel,* [2]*The Veterinary Institute, Bet Dagan, Israel,* [3]*Agricultural Research Organization, Bet Dagan, Israel*.

Effects of endotoxin (LPS) during estrus (E) or CL formation were studied in lactating Holstein cows. In Exp. 1, synchronized cows were watched continuously for estrous behavior. LPS was given iv (500 ng/kg) or intra-mammary (imm, 10 ug/cow), 16 h prior to expected onset of E (iv, n=4; imm, n=4), and at onset of standing E (iv, n=13; imm, n=8). Time of ovulation (OV) was determined by ultrasound during 4 days (d). LPS typically induced hyperthermia and increased plasma cortisol (ANOVA, $P<0.05$). Five cows receiving LPS prior to E (iv and imm) responded abnormally: two neither showed E nor ovulated during 4 d; three that showed E 36 h later than normal, then ovulated after a normal interval (within 30 h). Four cows (31%) receiving LPS iv at E onset responded abnormally: one did not ovulate during 4 d, three shortened their E behavior, showed additional E 60 h later, then ovulated within 30 h. 3 cows (38%) receiving LPS imm at E onset responded abnormally: one did not ovulate during 4 d, two showed normal E but a delayed OV. A delayed OV was associated with a delayed progesterone concentration rise ($P<0.05$). Collectively, 34% of cows responded abnormally after LPS at E (iv or imm, $P<0.05$). Control cows (n=12) showed normal E and a normal interval to OV. In Exp. 2, cows were given a single imm LPS dose on d 3 (n=5) or d 5 (n=5) of the cycle. The general pattern of follicular dynamics and progesterone concentrations were not affected by LPS treatment. However, the cycle was extended in 5 of 10 cows (50%) treated with LPS on d3 or d5: three did not show E and did not ovulate by 30 d after the previous E; two had extended cycle (27 d). Of the control cows (n=4), only one had an extended cycle (28 d), three had normal length cycles (22.6 d). Results show that exposure to endotoxin around E delays E and/or time to OV in about one-third of cows; a similar proportion of cows exposed to LPS at time of CL formation exhibited an extended cycle length.

Key Words: Endotoxin, Estrus, Dairy Cows