and foal serum IgG were not affected by treatment. Response to PHA injection was greater (P=0.0001) in mares compared to foals, but similar between treatments. Although the addition of n-3 FA to the mare's diet altered the FA content of milk and mare and foal plasma, changes in immune response were not detected.

Key Words: Omega-3 fatty acids, Immune response, Horse

459 Effects of dietary fish oil and flaxseed on plasma fatty acid composition and immune response in yearling horses. K. R. Vineyard*[1], L. K. Warren[1], K. A. Skjolaas[2], J. E. Minton[2], and J. Kivipelto[1], [1]*University of Florida*, *Gainesville*, [2]*Kansas State University*, *Manhattan*.

To determine the effects of different sources of dietary n-3 fatty acids on plasma FA composition and immune response in yearling horses, 18 Quarter Horse yearlings were randomly assigned to one of three treatments: encapsulated fish oil (FISH, n=6), milled flaxseed (FLAX, n=6), or no supplementation (CON, n=6). FISH contained 15 g eicosapentaenoic acid (EPA) and 12.5 g docosahexaenoic acid (DHA) and FLAX contained 61 g ∝-linolenic acid (ALA) per 100 g fat. Horses had free access to bahiagrass pasture and were individually fed a grain mix concentrate at 1.5% BW/d. FISH and FLAX were mixed into the concentrate in amounts to provide 6 g total n-3/100 kg BW. Horses were fed their respective treatments for 70 d. Blood samples were obtained at 0, 35 and 70 d for determination of plasma FA and isolation of peripheral blood mononuclear cells (PBMC). PBMC were stimulated with Concanavalin A and phytohemagglutinin (PHA) for determination of lymphocyte proliferation (LP). PBMC collected on d 70 were also challenged with lipopolysaccharide (LPS) to determine PGE_2 production. On d 70, horses were injected intradermally with PHA, and skin thickness and area of swelling were evaluated over a 48 h period to assess *in vivo* inflammatory response. Treatment did not affect body weight gain (mean±SE, 41.8±1.9 kg). Horses fed FISH had higher (P<0.05) plasma EPA, DHA and total n-3 and lower (P<0.05) plasma linoleic acid, ALA and n-6:n-3 FA ratio than FLAX and CON. PBMC positively responded to mitogen stimulation and PGE_2 increased in response to LPS, but treatment did not affect LP or PGE_2 production. Across treatments, peak increase in skin thickness was observed between 4 h and 6 h after PHA injection. At 4 h post injection, FISH and FLAX had a greater increase in skin thickness than CON (P<0.05) and FISH had a larger area of swelling than CON at 4 h and 12 h (P<0.05). Although fed to supply a similar level of n-3 FA, FISH had a greater impact on plasma n-3 FA and n-6:n-3 ratio than FLAX. However, both FISH and FLAX demonstrated a more pronounced early inflammatory response to PHA injection than unsupplemented horses.

Key Words: Omega-3 fatty acids, Immune response, Equine

460 Effects of fatty acid supplementation on plasma fatty acid concentrations and characteristics of the first postpartum estrous in mares. T. A. Poland*[1], J. M. Kouba[1], C. M. Hill[1], C. Armendariz[1], J. E. Minton[1], and S. K. Webel[2], [1]*Kansas State University*, *Manhattan*, [2]*JBS United, Inc.*, *Sheridan, IN*.

Fat supplementation of horse diets has traditionally utilized sources rich in n-6 fatty acids. The objective of this study was to evaluate the effects of supplementing mares with protected marine-derived n-3 fatty acids (JBS United) during late gestation and early lactation. Twenty Quarter-type mares were randomly assigned to one of three treatment groups. Beginning 60 d prior to the expected foaling date, mares were fed either a control diet (CON, concentrate base with added corn oil, n=6), a docosahexaenoic acid (DHA) supplemented diet (D, n=7), or a eicosapentaenoic acid (EPA) / DHA supplemented diet (ED, n=7). Diets continued after parturition through the first postpartum estrous cycle. Mare plasma was collected at the start of treatment, at parturition, and at wk 3 postpartum. Gas chromatography was used to analyze mare plasma for linoleic acid (LA), arachidonic acid (AA), alpha-linolenic acid (ALA), EPA, and DHA. Gestation length did not differ between treatment groups. The time from foaling to the first postpartum ovulation was increased (P<0.01) in the ED group (22.5±2.1 d) compared to both the CON (12.5±2.3 d) and D (13.3±2.3 d) groups. The length of time that mares in the ED group held a large (≥ 35 mm) follicle during the first postpartum estrous period was increased (P<0.05, 12.7±1.9 d) compared to the CON (6.3±2.0 d) or D (6.0±2.0 d) groups. Mare plasma LA and ALA concentrations were not affected by treatment. AA was elevated (P<0.05) in D mares at parturition and 3 wk postpartum compared to the CON mares. DHA was increased (P<0.01) in both the ED and D mares at parturition and 3 wk postpartum compared to the CON group. EPA was increased (P<0.01) in ED mares at parturition and 3 wk postpartum compared to both the D and CON mares. Feeding mares diets high in EPA may result in increased follicle retention and affect timing of ovulation in the early postpartum period.

Key Words: Mare, n-3 fatty acids, Follicle

Nonruminant Nutrition: Sow Nutrition and Gilt Development

461 Determining the threonine requirement of the lactating sow. J. D. Schneider*, M. D. Tokach, S. S. Dritz, R. D. Goodband, J. L. Nelssen, and J. M. DeRouchey, *Kansas State University*, *Manhattan*.

A total of 182 lactating sows were used to determine the optimal threonine:lysine ratio, and the relative difference in performance of diets with high levels of crystalline amino acids compared to a corn-soybean meal diet. All experimental diets were corn-soybean meal-based and formulated to contain 0.88% true ileal digestible (TID) lysine (1.00 and 0.97% total lysine for the control and crystalline amino acid diets, respectively). Diets were formulated to be below the expected lysine requirement of the sows based on modeled performance of previous farrowing groups. The control diet contained no added crystalline amino acids, whereas the five other diets contained 0.37% L-lysine HCl with other amino acids added to ensure threonine was first limiting. The TID threonine levels in these diets were formulated to 0.44, 0.50, 0.57, 0.64, and 0.70%. Sows were randomly allotted to the dietary treatments based on parity. Over the entire lactation period, sows fed the diets containing crystalline amino acids consumed more (P < 0.04) feed than the sows fed the control corn-soybean meal diet (5.5 vs 5.1 kg, respectively). Sows fed the control diet lost numerically (P > 0.10) more weight (15.1 vs 12.9 kg) over the lactation period and had higher (P < 0.01) PUN on d 18 of lactation than sows fed diets

with added crystalline amino acids. Increasing threonine had no effect (P > 0.10) on litter weaning weight (average 65.8 kg). Based on litter weaning weights the expected dietary lysine requirement of these sows would have been 55 g/d compared to the 48 g/d of actual lysine intake, confirming we were below the sow's requirement for lysine. Numeric changes in PUN, litter weight gain, and feed intake suggest the TID threonine requirement was approximately 0.50%, suggesting a TID threonine to lysine ratio of 57%. The greatest implication of this study, however, was that the use of crystalline amino acids as a replacement for soybean meal in lactation diets resulted in increased feed intake and tended to decrease sow weight loss.

Key Words: Lactation, Sows, Threonine

462 Progenos in sows increases number of piglets born. P. Ramaekers*[1], B. Kemp[2], and T. van der Lende[2], [1]*Nutreco Netherlands BV*, *Boxmeer, The Netherlands*, [2]*Department of Animal Sciences*, *Wageningen, The Netherlands*.

In two experiments the effect of Progenos in pregnant sows was examined on litter traits and farrowing rate. Progenos contains 25% L-Arginine. Two hundred ten multiparous Hypor sows were used in Exp. 1. One hundred thirty six primiparous and two hundred ten multiparous PIC sows were used in Exp. 2. In both experiments, one hundred g Progenos was fed to pregnant sows from day 14 throughout day 28 of gestation. Control groups received a placebo without L-Arginine. In Exp. 1, Progenos increased (P<0.05) litter size (+0.8 piglet/litter) and farrowing rate (+11.6%). Progenos did not affect the fraction of still born piglets and birth weight, but increased (P<0.05) the within-litter standard deviation for birth weight (+31g). In Exp 2, Progenos increased in primiparous and multiparous (P<0.05) total born piglets (+1.25/litter and +1.18/litter) and piglets born alive (+1.08/litter and +0.93/litter), respectively. Farrowing rate was not affected (P>0.1) by treatment. A potential explanation for the effect of Progenos might be that L-Arginine stimulates angiogenesis and might thereby influence placental efficiency. This leads to extra survival of those fetuses that normally do not survive. It is concluded that Progenos has a positive effect on litter size in primiparous and multiparous sows.

Key Words: L-Arginine, Pig, Litter size

463 Dietary protein concentration alter amino acid extraction rate across the porcine mammary gland during lactation. J. Perez Laspiur and N. L. Trottier*, *Michigan State University*, *East Lansing*.

Six multiparous sows were used to determine if amino acid (AA) extraction rate by the porcine mammary gland is affected by the availability of dietary AA. Sows were fed graded concentrations of crude protein (CP) consisting of 12, 18, and 24% CP to limit, meet, or exceed, respectively, protein and AA requirements. Sows were fitted with mammary vein and carotid artery catheters between d 3 and 5 of lactation. Arterial and venous blood samples were collected on d 10, 14, and 18 of lactation. For each blood sampling day, blood samples were collected every 30 min for a total of 3 h, and samples pooled per sow. Repeated measures analysis was used for repeated measures over days of lactation and relationships between dietary CP intake and response variables (AA extraction rate, piglet ADG, sow feed intake) were determined by linear and quadratic orthogonal contrasts. Differences were considered significant at P < 0.10 while tendency for differences were considered at P < 0.2. Dietary protein intake (g/d) did not differ with increasing dietary CP concentration (732, 787 and 871 ± 144 g/d for 12, 18 and 24% CP diet, respectively). Piglet ADG tended to decrease linearly (P = 0.12) with increasing dietary CP concentration. Mammary extraction rates of arginine and lysine decreased linearly (P = 0.06) while threonine and valine tended to decrease linearly (P = 0.13 and 0.18, respectively) with increasing dietary CP concentration. Leucine and phenylalanine extraction rates increased with increasing CP concentration from 12 to 18% and decreased with increasing CP concentration from 18 to 24% (quadratic, P = 0.09 and 0.07, respectively). In conclusion, mammary AA extraction rates decreased with increasing dietary CP concentration from deficient to excess, with little change in dietary AA availability. Conversely, the decrease in dry matter and(or) energy intake with increasing dietary CP concentration may have limited mammary AA extraction.

Key Words: Amino acid transporter, Mammary gland, Porcine

464 Dietary protein intake and stage of lactation differentially alter amino acid transporter gene expression in porcine mammary gland. J. Perez Laspiur*, J. L. Burton, P. S. D. Weber, and N. L. Trottier, *Michigan State University*, *East Lansing*.

The objective of this study was to determine if dietary AA and stage of lactation regulate AA transporter gene expression in porcine mammary tissue (MT). Eighteen sows were used in a 2 x 3 randomized block design consisting of two stages of lactation and three dietary treatments. Diets limited (12% CP; Deficient), met (18% CP; Adequate) or exceeded (24% CP; Excess) protein and AA requirements for lactation. Biopsies of MT were collected between d 3 and 6 (early) and d 17 and 19 (peak) of lactation. Increasing CP concentration did not affect sow feed intake but increased CP intake (linear, P ≤ 0.001) (565, 911, and 1315 ≤ 47 g/d for 12, 18, and 24% CP, respectively). Dietary protein intake did not affect milk yield. Milk CP and casein yield, and piglet ADG increased as CP intake increased from Deficient to Adequate and decreased as CP intake increased further to Excess (quadratic, P ≤ 0.05). Plasma glucose (mg/dL) did not change with dietary CP concentration while plasma concentration for the majority of AA increased linearly (P ≤ 0.01). Transporters CAT-1, CAT-2B, ASCT1 and $B^{0,+}$ mRNA in MT was quantified by real-time PCR. Increasing CP from Deficient to Excess decreased the expression of CAT-2B (linear, P ≤ 0.05). Dietary CP intake had no effect on expression of CAT-1, ASCT1 and $B^{0,+}$. Expression of ASCT1 and $B^{0,+}$ was higher at peak compared to that of early stage of lactation (P ≤ 0.01), while expression of CAT-1 and CAT-2B remained unchanged. In conclusion, milk protein and casein yield, and neonatal pig growth were impacted by dietary CP intake and plasma AA availability. Only CAT-2B responded to changes in AA availability at the transcription level, suggesting that CAT-2B may be involved in regulating cationic AA transport into MT for protein synthesis. Increasing lactation demand increased ASCT1 and $B^{0,+}$ mRNA abundance, while the CATs remained unchanged, suggesting a different regulatory pathway for non-cationic AA transport across the mammary gland in vivo.

Key Words: Amino acid transporter, Mammary gland, Porcine

465 An omega-3 enriched diet mitigates inflammatory mediators derived from ex vivo porcine cartilage explants. M. W. Orth*[1], J. D. Spencer[2], C. I. O'Connor[1], P. M. Wolfe[1], and J. B. Wheeler[1], [1]*Michigan State University*, *East Lansing*, [2]*JBS United, Inc.*, *Sheridan, IN*.

Omega-3 fatty acids, specifically eicosapentaenoic acid (EPA) and docosahexaenoic acid (DHA), may reduce the inflammation associated

with joint pain. The objective of this study was to determine if long-term supplementation of long chain protected polyunsaturated fatty acids (PUFAs) in sow rations alter the metabolism of cartilage ex vivo. Sows (6 sows/trt) were fed either control corn/soybean meal based diets, or the control diets supplemented with 0.5 to 1.0% protected PUFA from Fertilium (JBS United, Sheridan, IN). Sows were fed their respective treatments continuously for at least three parities prior to slaughter and harvesting of both forelimbs approximately 2 inches above the humeral-ulnar joint. Cartilage explants (6 mm disks) were isolated and placed, 2 per well, in a 24-well culture plate, with twelve wells per animal. Explants were cultured in DMEM: Ham's F-12 modified serum free medium with no exogenously added fatty acids or cultured in the same media and challenged daily with porcine Interleukin-1 (pIL-1; 10 ng/ml) to stimulate inflammatory pathways. Media were collected every 24 h for 3 d and analyzed for the production of nitric oxide (NO), PGE_2, and Interleukin-6 (IL-6). Proteoglycans in the media were measured as an indicator of cartilage catabolism. Statistics were analyzed using proc mixed of SAS 8.2 with sow, day, pIL-1 addition, and diet as class variables. Explants from sows fed PUFAs had reduced proteoglycan and IL-6 release regardless of pIL-1 challenge (Diet $P < 0.05$). The pIL-1 challenge increased NO production (pIL-1 x Day $P < 0.01$) and sows fed PUFAs had a 31% reduction in NO production, but the impact of PUFA feeding was not significant (Diet $P = 0.30$). Media PGE_2 concentrations were not different among treatments. Thus, 2 out of the 4 indicators of inflammation were significantly mitigated in cartilage explants following long-term supplementation with protected PUFAs. These results suggest that protected PUFAs containing high levels of EPA and DHA can alter chondrocyte metabolism in vivo.

Key Words: Arthritis, Health, Swine

466 Varying dietary cation-anion difference in late gestation and in lactation on sow productivity. M. L. Roux*[1], P. W. Jardon[2], S. L. Johnston[1], T. D. Bidner[1], and L. L. Southern[1], [1]*LSU Agricultural Center*, *Baton Rouge*, [2]*West Central*, *Ralston, IA*.

Primiparous or multiparous sows and their pigs were used to evaluate the effects of changing dietary cation-anion difference (DCAD; Na + K - Cl - S) in late gestation and in lactation on sow productivity. In a preliminary experiment (20 sows), urinary pH was linearly decreased ($P < 0.001$) as DCAD decreased in the diet (DCAD; 140, 99, 75, and 45 mEq/kg). Reducing DCAD tended to linearly increase ($P = 0.15$) plasma Ca concentrations. Thus, in Exp. 2, 66 sows (33 per treatment) were used and the dietary treatments consisted of corn-soybean meal diets with DCAD of 140 or 45 mEq/kg. These DCAD's were achieved by 0 or 3.5% added SoyChlor 16-7. The diets were fed from d 111 of gestation to weaning. Sows were allotted based on parity and the date of d 111 of gestation. Reducing DCAD reduced ADFI from d 111 of gestation to d 1 postfarrowing ($P < 0.02$), but ADFI was not affected by DCAD during lactation or overall ($P > 0.10$). Sow weight change was not affected by DCAD ($P > 0.10$). Reducing DCAD did not affect total number pigs born, pigs born alive, stillbirths, mummies, number nursed, number weaned, percent survivability, live and total birth weights, initial litter weight adjusted for mortality and cross-fostering, final litter weight, or litter weight gain ($P > 0.10$). Decreasing DCAD in the diet decreased urinary pH ($P < 0.001$) but had no effect on plasma Ca concentration. Twenty-seven sows fed the control diet and 21 sows fed the reduced DCAD diet were evaluated during their subsequent farrowing. Sows that had been fed the reduced DCAD diet had increased total number of pigs born ($P < 0.08$) and pigs born alive ($P < 0.02$) in the subsequent farrowing. Stillbirths, mummies, and live and total birth weights were not affected in the subsequent farrowing by DCAD. Changing DCAD had little affect on sow and litter response variables, but it decreased urine pH ($P < 0.001$) and increased total number of pigs born and pigs born alive in the subsequent farrowing.

Key Words: Electrolyte balance, Sows, Urinary pH

Production, Management and the Environment III

467 Carry-over effect of extended photoperiod during pubescence on first lactation in beef heifers. J. A. Small*[1] and A. D. Kennedy[2], [1]*Agriculture & Agri-Food Canada*, *Brandon, MB, Canada*, [2]*University of Manitoba*, *Winnipeg, MB, Canada*.

A 2*2 factorial arrangement of photoperiod treatments in autumn (A) and winter (W) was applied to spring-born crossbred beef heifers (N=540 over 6 yrs) assigned at weaning (Sep; 0 wk), by body weight and age, to one of four pens in one of two similar open shed/drylot facilities. Supplemental light (350 lux, 1 m above ground) was used to extend photoperiod (natural + supplemental light) to 16 h for 12 wk starting in Sep (A), or Dec (W), or for both periods (AW), while the control group was exposed to natural photoperiod (NP) only. Heifers were fed diets formulated to achieve 60% mature body weight at 32 wk through one of three feeding strategies: low gain during the prepubescent (0.6 kg d-1; 4 to 16 wk), high gain during the pubescent (1.2 kg d-1; 16 to 24 wk) and moderate gain during the post-pubescent (0.7 kg d-1; 24 to 32 wk) period, or low, low, high and constant (0.9 kg d-1) gain throughout these periods, respectively. In May each year heifers were synchronized for fixed-time AI (0 d) followed by exposure to bulls (2-42 d) and turn-out. In the fall bred heifers continued in one management group. At 8 wks postpartum heifers were milked, separated from their calves and milk collected 8 h later used to determine yield and composition. Data were analyzed as a 2*2*3 factorial using Proc Mixed and included the random effect of year. Mean pre- and post- calving body weights and condition scores, and calf birth weight of milked heifers were similar (P>0.05) among treatments. Yield of milk (8.3±0.3, 8.3±0.2, 7.9±0.3 and 7.6±0.2 kg d-1), protein and solids not fat were greater for A- or W- than AW- and NP treatments, respectively (P=0.05). Feeding strategy had no significant effect (P>0.05) on milk, body weight or condition. Extended photoperiod treatment during pubescence increased first lactation milk yield by 9.2%.

Key Words: Beef heifer, Photoperiod, Lactation