518 Phospholipids and plasmalogens as precursors of flavor in beef. S. Lorenz*[1], P. Schieberle[2], K. Ender[1], and K. Nuernberg[1], [1]*Research Institute for the Biology of Farm Animals,* [2]*Deutsche Forschungsanstalt fuer Lebensmittelchemie*.

Fatty acids are known precursors of several characteristic flavor compounds of meat. (E,E)-2,4-decadienal, nonanal or 1-octen-3-one originating from different precursor fatty acids have been confirmed as character impact odorants of, e.g., stewed beef juice. But there is another important characteristic odorant detected in stewed beef juice. The branched aldehyde 12-methyltridecanal (12-MT), smelled tallow and beef-like, is bounded in plasmalogens. The major objective of this study was to develop a method for the determination of 12-MT in plasmalogens using high-performance liquid chromatography (HPLC). A second objective was to estimate the fatty acid composition of the phospholipids and plasmalogens using gas chromatography. The HPLC procedure for 12-MT based on the formation of 2,4-dinitrophenylhydrazones of carbonyl compuonds. After purification the derivates can be separated with an HPLC system with acetonitrile-water on RP-18 silica gel column. The fatty acid composition was carried out on a 100 m CP Sil-88 column with hydrogen as carrier gas. Ten (group A: pasture, n = 6; group B: concentrate, n = 4) German Simmental cattle were used in the investigation. The phospholipids of the longissimus were separated into different classes using thin layer chromatography. The major classes of beef muscle were phosphatidylcholine (PC) and phosphatidylethanolamine (PE). The PC content was significantly ($P < 0.05$) higher in group B (245 mg) to 264 mg / 100 g muscle (group A). The amount of PE showed with 151 mg (group A) and 142 mg/100 g muscle (group B) no significant difference. The aldehyde composition of both PC and PE was estimated using HPLC. The major aldehydes are hexadecanal and octadecanal. The different feeding system led to significant ($P < 0.05$) changes of both aldehydes in the class of PE. Octadecanal, e.g., increased from 3.3 mg (group B) to 4.7 mg / 100 g muscle (group A). However, lower chain aldehydes (C10 # C14) could be identified, too. PC showed the highest amount of 12-MT with 17.1 μg (group A) and 13.0 μg / 100 g muscle (group B). There was no significant difference between the groups.

Key Words: phospholipid, beef, aldehyde

Nonruminant Nutrition
Amino Acid and Protein Nutrition

519 Foundations for current knowledge of protein and amino acids for swine. W. Pond, *Cornell University, Ithaca, NY.*

The present knowledge of protein and amino acid (AA) requirements in swine is based on a continuum of research spanning nearly a century. Hanson (J. Anim. Sci. 17:1029-1057, 1958) reviewed 50 years of progress in the early understanding of protein and AAs in swine nutrition. McCollum and Steenbock in 1912 and Osborne and Mendel in 1914 set the stage for the concept of essential AAs when they reported that zein (the major protein of corn) supported rat survival, but not growth, and that the addition of missing AAs promoted growth. In the 1930s, W.C.Rose reported the AAs required for rat growth; this formed the basis for the flood of research in the 1950s which established that the growing pig requires the same 10 AAs as the growing rat. Early methods to establish AA requirements of swine were focused mainly on measurements of growth and N-balance. The concepts of AA imbalance and of interactions among AAs and between AAs and other nutrients emerged during the 1950s and 1960s. More recent studies refined estimated AA requirements for growth, gestation and lactation. Other refinements, such as ileal digestibility and the concept of ideal protein, based on optimum ratios of AAs, were also made possible by the efforts of earlier investigators. The advent of inexpensive crystalline AAs for addition to feeds marked yet another major advance in efficient protein utilization. The future of AA and protein research and its application promises even more exciting discoveries.

Key Words: Amino acids, Protein, Swine

520 Whole body and hindlimb protein breakdown is differentially altered by feeding in piglets. M.C. Thivierge*[1&2], H.V. Nguyen[1], J.A. Bush[1], A. Suryana[1], R. Orellana[1], C.W. Liu[1], D.G. Burrin[1], F. Jahoor[1], and T.A. Davis[1], [1]*USDA/ARS Children's Nutr. Res. Ctr., Dept. Pediatr. Baylor Coll. Med., Houston, Texas* , [2]*FSAA, Universit Laval, QC, Canada*.

The neonatal period is characterized by a high rate of muscle protein accretion, which is due, at least in part, to an elevated rate of skeletal muscle protein synthesis in response to feeding. However, little is known about the regulation of protein breakdown by feeding during the neonatal period. To determine the feeding-induced response of protein breakdown at the whole body level and across the hindlimb, overnight-fasted 28-day-old pigs (n=6) were infused for 7 h with [1-13C]phenylalanine and [ring-D4]tyrosine during an initial 4 h fasting period and a 3 h refeeding period. Refeeding was achieved by continuous intraduodenal infusion of an elemental diet. Plasma samples were obtained simultaneously from the carotid artery and the vena cava; blood flow of the caudal aorta was recorded using ultrasonic flow probes. The results indicate that refeeding increased whole body phenylalanine flux (+92%), phenylalanine oxidation (+300%), and whole body protein synthesis (+81%). Refeeding decreased whole body protein breakdown (-45%); protein breakdown represented 28% of whole body flux in the refed state. Phenylalanine hydroxylation to tyrosine increased with refeeding (+7-fold). In the hindlimb, refeeding increased the utilization of phenylalanine for proteins synthesis (+233%) and this was associated with an increase in blood flow (+20%). However, refeeding did not alter protein breakdown in the hindlimb. The ratio of hindlimb protein breakdown over hindlimb phenylalanine flux indicates that muscle protein is mobilized during the fasting period but that protein degradation accounts for only 30% of hindlimb flux during the refeeding. Thus, the results show that proteolysis is more sensitive to feeding at the whole body level than in the hindlimb in 28-day-old piglets. Furthermore, the protein anabolic response to feeding in the hindlimb is driven primarily by a stimulation of protein synthesis.

Key Words: Proteolysis, Hindlimb, Piglets

521 Low protein diets can be fed to gestating sows without adverse effects. S. Möhn*, D. J. McMillan, and R. O. Ball, [1]*University of Alberta, Edmonton*.

Reducing dietary protein content can reduce the N excretion of pigs. Performance should not be affected if low protein diets are supplemented adequately with free amino acids. We tested the effect of supplemented low protein diets on the performance of 80 sows during their second and third parity. Sows were offered isoenergetic barley-based diets containing either 14.8 % crude protein (CP, group HP) or 12.0% CP with added lysine and threonine (LP). At allocation, breeding body weight (BW) and back fat (BF) were similar for HP and LP. Litter size and weight in the first parity were similar for LP and HP. At similar daily feed intake (LP: 2.23 0.03 kg, HP: 2.25 0.02 kg), weight gains during pregnancy were similar in LP (55.9 1.1 kg) and in HP (55.4 1.2 kg). BF when 40 d or 95 d pregnant were similar in LP (19.7 0.5 mm and 19.6 0.4 mm, respectively) and HP (19.3 0.5 mm and 19.2 0.3 mm, respectively). At breeding for the third parity, BW in LP was lower (180.3 2.2 kg) than in HP (186.8 2.5 kg, $P = 0.05$), but BF was similar (LP: 17.0 0.4 mm, HP: 17.0 0.4 mm). By day 40 of the third parity, BW was similar in LP (202.4 1.7 kg) and HP (205.0 2.2 kg). At similar daily feed intake (LP: 2.47 0.03 kg, HP: 2.51 0.03 kg), weight gains during the third pregnancy were slightly greater ($P = 0.098$) in LP (66.4 1.4 kg) than in HP (62.7 1.6 kg). BF when 40 d or 95 d pregnant were similar in LP (17.8 0.4mm and 18.5 0.3 mm, respectively) and HP (17.7 0.4 mm and 18.5 0.3 mm, respectively). Parity had no effect on N excretion determined in 6 animals per group. Urinary N to creatinine ratio showed that N excretion in LP was lower ($P = 0.04$) by 28.7% compared to HP during early pregnancy. During late pregnancy, N excretion was similar for HP and LP. Overall, N excretion tended to be lower ($P = 0.08$)by 19.4% in LP compared to HP. Our results indicate that low protein diets can be used successfully for pregnant sows because they promote the same growth rate as conventional diets while reducing N excretion. Funding was provided by Alberta Pork, AARI and Degussa AG.

Key Words: Sows, Gestation, Protein intake

522 Low protein diet for sows reduce carbon dioxide and heat production. J.K.A. Atakora*, D.J. McMillan, S. Möhn, and R.O. Ball, *University of Alberta*.

Carbohydrates are used more efficiently than protein in intermediary energy metabolism. Low protein diets supplemented with amino acids have a greater content of carbohydrates and lower excess of protein than conventional diets. Therefore we hypothesized that low protein diets would reduce the production of CO_2 and heat by sows during gestation and lactation. Twenty-two sows were fed either conventional diets (HP) or amino acid supplemented, low-protein diets (LP) during gestation and lactation of the second and third parities. Oxygen consumption and CO_2 production were measured using an open-circuit respiration system. Heat production was calculated based on gas exchange. During gestation, average production of CO_2 was lower in LP ($P = 0.04$; 3029 317 g/d) than in HP (3183 386 g/d). Allowing for the covariates feed intake, sow weight and parity ($P < 0.01$), CO_2 production in LP was reduced by 4.8% relative to HP ($P = 0.03$). Mean heat production during gestation was lower in LP ($P = 0.01$; 37.9 4.2 MJ/d) than in HP (40.1 4.3 MJ/d). Heat production during gestation was also affected by sow weight, feed intake and ambient temperature ($P < 0.05$). During lactation, average CO_2 production was about 7% less for LP ($P = 0.01$; 6508 842 g/d) than HP (7016 824 g/d). Parity, feed intake and piglet weight also affected CO_2 production during lactation ($P < 0.05$). Mean lactation heat production was lower in LP ($P = 0.01$; 51.8 9.3 MJ/d) than in HP (57.2 8.9 MJ/d). Regression analysis showed that heat production decreased with protein intake (LP, $P = 0.001$) and increased with feed intake and litter weight ($P = 0.001$). Feeding low protein diets to sows in commercial operations will significantly reduce carbon dioxide production, thus contributing to a reduction of greenhouse gas production. The reduced heat production indicates an improved nutrient utilization in low protein diets.

Key Words: Sows, Protein intake, Heat production

523 Effect of litter size and day of lactation on amino acid uptake by the porcine mammary glands. T.T. Nielsen[1], N.L. Trottier*[2], H.H Stein[1], C. Bellaver[1], and R.A. Easter[1], [1]*University of Illinois, Urbana-Champaign, Illinois, USA,* [2]*Michigan State University, East Lansing, Michigan, USA*.

Twelve multiparous sows were used to investigate the relationship between litter size and day of lactation, and plasma amino acid (AA) arteriovenous differences (A-VD), AA uptake, and plasma flow across the mammary glands. Sows were assigned randomly to one of the following litter sizes: 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, or 14 pigs per litter by cross fostering on d 2 postpartum. All sows were surgically fitted with catheters in the carotid artery and the main mammary vein. Matched arterio-venous blood samples were obtained on d 9, 12, 15, 18, 21, and 24 postpartum. Daily mammary uptake of AA was based on the product of plasma A-VD and daily mammary plasma flow (MPF). Daily MPF was estimated using the Fick method based on lysine conservation across the gland, and daily milk production. For the majority of AA, as litter size increased, A-VD did not increase, except for alanine ($P < 0.05$, linear and quadratic) and valine ($P < 0.1$, linear and quadratic). As day of lactation increased, A-VD for the majority of AA increased ($P < 0.05$, linear and quadratic) except for arginine, lysine and phenylalanine. As litter size increased, net daily mammary AA uptake increased for all indispensable AA ($P = 0.001$ to $P < 0.05$, linear and quadratic), excepting arginine. Milk production increased with increasing litter size ($P < 0.001$, linear) and with increasing day of lactation ($P < 0.05$, quadratic). Daily MPF increased ($P < 0.05$, linear) with increasing litter size, but did not change during the period measured from d 9 to 24. In conclusion, litter size appears to be a major determinant of net mammary AA uptake with daily MPF a driving variable, whereas AA A-VD is a function of day of lactation and a major variable in determining net AA uptake with advancement of lactation.

Key Words: Lactating sow, Amino acid, Mammary gland

524 Supplemental arginine in diets of lactating sows: effect on plasma nitric oxide and milk amino acid concentration. J. Perez Laspiur*, A. Zanella, P. K. Ku, and N. L. Trottier, *Michigan State University*.

Our previous work has shown that heat stress (HS) in lactating sows decreases milk production and average daily gain of nursing pigs. We hypothesized that the decrease in milk production is caused in part by a decrease in plasma nitric oxide and milk amino acid concentration. The objectives of this study were to determine 1) if HS decreased nitric oxide (NO) and arginine (arg) concentration in plasma, and amino acid (AA) concentration in milk and 2) if dietary arg supplementation increased plasma NO and milk AA concentrations. Sows (n=42) were exposed to a thermoneutral (TN=20°C) or hot (HT=29.4°C) environment and allocated to one of three dietary treatments in a 2×3 factorial design. Diets contained 0.96%, 1.34%, and 1.73% arg for control (C), medium (M), and high (H), respectively. Blood samples were collected on day 21 of lactation. On day 7, 14, and 21 of lactation, milk samples were obtained (n=18) manually from the first two anterior mammary glands. Differences in responses to HS and arg supplementation were determined by analysis of variance. Statistical analysis was performed using the MIXED procedure of SAS. Compared to TN sows, HT sows had lower ($P<0.05$) plasma concentrations of isoleucine, phenylalanine and threonine, and milk concentrations of arg, leucine, lysine, phenylalanine and valine. Plasma NO concentration was not different between TN or HT sows. Arginine supplementation increased arg and threonine concentrations in plasma ($P<0.05$) and increased proline concentration in milk ($P<0.05$) in HT sows. Arginine supplementation did not increase plasma NO concentration in either TN or HT sows. In conclusion, HS did not decrease the concentration of arg in plasma, but decreased the concentration of arg, lysine, and large neutral AA in milk. Supplemental arg did not increase NO concentration in plasma in either TN or HT sows, but increased proline concentration in HT sows. These results suggest that the decrease in milk production observed in sows exposed to HS may result from a decreased uptake of AA by the mammary glands.

Key Words: Lactating sow, Arginine, Milk production

525 Effect of crude protein reduction and dietary fiber on nitrogen retention and excretion in the growing pig. J. Perez-Laspiur*, C. Wickens, L. Recker, J. Moore, P.K. Ku, and N.L. Trottier, *Michigan State University, East Lansing, Michigan, USA*.

Forty-eight 50-kg barrows were used to determine if dietary crude protein (CP) reduction and dietary fiber inclusion decreases nitrogen (N) excretion (E) without reducing N retention (R). Pigs were allocated to one of six dietary treatments in a randomized block design. Diets were 15.5% CP, 12.5% CP, and 9.5% CP, 12.5% CP containing 10% wheat middlings (WM), 12.5% CP containing 10% sunflower hulls (SH), and 12.5% CP containing 10% corn distillers grains (CDG). Synthetic amino acids were added to the 12.5%, 9.5%, WM, SH, and CDG diets. Feed was either restricted (FR) or provided ad lib (FA). Each block consisted of a 14-day adaptation period to diets followed by a 6-day fecal and urine collection period. Feces were collected via bags directly attached on the skin surrounding the anus. The FR and FA were fed at 3.5 and 5% of BW, respectively. Reducing CP from 15.5 to 12.5% did not reduce NR for either FR or FA group and reduced ($P < 0.05$) total daily N and urinary N. Reducing CP from 15.5 to 9.5% reduced ($P < 0.05$) total daily N and urinary N, but decreased ($P < 0.05$) NR in both FR and FA groups. When compared to the 12.5% CP diet, WM, SH, or CDG diets yielded similar NR and urinary N excretion. In conclusion, reducing CP from 15.5 to 12.5% reduced daily urinary excretion and did not compromised NR. Feeding a diet containing 9.5% CP dramatically reduced daily N excretion but also decreased NR. Addition of fiber sources such as WM, SH, or CDG at 10% of the diet to a 12.5% CP diet did not reduce urinary N excretion compared to that in pigs fed a 12.5% CP diet.

Key Words: Pig, Nitrogen excretion, Dietary protein

526 Effect of crude protein reduction and dietary fiber on fecal urease and urinary nitrogen form in the growing pig. J. Perez-Laspiur, C. Wickens*, L. Recker, J. Moore, P.K. Ku, and N.L. Trottier, *Michigan State University, East Lansing, MI, USA*.

Forty-eight 50-kg barrows were used to determine 1) if dietary crude protein (CP) reduction decreases fecal urease (FUase) concentration (conc.) and urinary pH, and increases urinary (U) ammonia (NH4) relative to urea conc.; 2) if dietary CP reduction with dietary fiber inclusion increases FUase conc. and decreases U pH and urea conc. Pigs were allocated to one of six dietary treatments in a randomized block design. Diets were 15.5% CP (15.5 CP), 12.5% CP (12.5 CP), 9.5% CP (9.5 CP),

and 12.5% CP containing 10% wheat middlings (WM), or sunflower hulls (SH), or corn distillers grains (CDG). Each block consisted of a 14-day adaptation period to diets and a 7-day fecal and urine collection period. Urinary pH was lower ($P < 0.05$) in 9.5 CP diet compared to 15.5 CP but not different between 12.5 and 15.5 CP. Daily production and conc. of FUase was lower ($P < 0.05$) for 9.5 and 12.5 CP compared to 15.5 CP. Urinary urea conc. was lower ($P < 0.01$) for 9.5 compared to 12.5 and 15.5 CP, and not different between 12.5 and 15.5 CP. Daily U urea production was lower for 9.5 ($P < 0.01$) and 12.5 CP ($P < 0.05$) compared to 15.5 CP. Urinary NH4 conc. and daily production was higher ($P < 0.05$) in the 9.5 compared to 12.5 and 15.5 CP, and not different between 12.5 and 15.5 CP. Urinary pH for WM, SH, and CDG diets was similar to 12.5 CP and lower ($P < .05$) for SH and CDG compared to 15.5 CP. Fecal urease conc. for WM, SH, and CDG was similar to 12.5 CP and lower ($P < .05$) for WM and CDG compared to 15.5 CP. Urinary urea conc. and production was not different for WM, SH, and CDG compared to 12.5, but production was lower compared to 15.5 CP. Compared to 12.5 and 15.5 CP, urinary NH4 conc. and production was not different for WM and SH, and was higher ($P < 0.05$) for CDG. In conclusion, reducing CP reduces FUase conc., U urea conc. and U pH, and increases U ammonia conc. Fiber inclusion in reduced CP diets does not increase FUase conc., and does not reduce U pH, urea and NH4 conc. or production.

Key Words: Pig, Fecal urease, Nitrogen excretion

527 Optimal true ileal digestible (TID) lysine dietary level in growing hybrid pigs. N. Warnants[1], M.J. Van Oeckel[1], M. De Paepe[1], L. Le Bellego*[2], and C. Relandeau[2], [1]*CLO-Ghent, Melle, Belgium,* [2]*Ajinomoto Eurolysine, Paris, France.*

Two trials were performed with Pietrain x Seghers Hybrid pigs of 4-10 weeks (trial 1) and 10-15 weeks of age (trial 2). In trial 1, 5 diets with rising TID lysine levels from 1.01 to 1.29% were fed to 66 pigs per treatment. Each pen was composed of 3 barrows and 3 gilts. In trial 2, 6 diets with levels of TID lysine increasing from 0.69 to 1.07% were fed to 45 barrows and 45 gilts per treatment. The sexes were housed separately in pens of 5. In both trials, diets were based on cereals and soybean meal and were balanced in threonine, methionine + cystine and tryptophan relatively to lysine, according to the ideal protein. Lysine:crude protein was 0.07 and NE contents were 9.62 (trial 1) and 9.41 MJ/kg feed (trial 2). In both trials DFI, ADG and FCR increased with dietary TID Lysine level ($P = 0.001$ for linear contrast). In trial 1, ADG (348 g/d) and FCR (1.59) were the highest with 1.22% TID lysine treatment, with a DFI of 554 g/d. Using a broken line model, the optimal requirement for ADG was 6.96 g/d or 1.22% TID lysine. FCR was described as a quadratic function of TID lysine intake and resulted in the same requirement (7.00 g/d). In trial 2, ADG and FCR were respectively highest and lowest for both barrows and gilts at 1.07% TID lysine with a DFI of 1403 (barrows) and 1260 (gilts) g/d. However, analysis of data using exponential and quadratic models suggest that the optima for ADG and FCR were above the investigated lysine range. Based on ADG and using an exponential model, the requirement for barrows could be estimated at 17.24 g/d or 1.23%. For gilts, it was not possible to determine the optimum as the relation between ADG and TID lysine intake was linear. For FCR, using a quadratic model, the requirement was 16.44 and 13.46 g/d or 1.17 and 1.07% TID lysine for barrows and gilts, respectively. These results demonstrate that lean modern genotypes have a daily TID lysine requirement close to traditional genotypes but require a higher TID Lysine concentration in the feed due to their limited feed intake capacity.

Key Words: TID lysine, Hybrid pig

528 Tryptophan:lysine ratios that optimize performance in 6 to 23-kg pigs. R.W. Fent*[1], R.D. Boyd[2], G.L. Allee[1], D.R. Cook[3], and M.M. Ward[3], [1]*University of Missouri-Columbia,* [2]*PIC USA, Inc., Franklin, KY,* [3]*Akey, Lewisburg, OH.*

Two experiments were conducted to determine minimum dietary tryptophan:lysine ratio (T:L) for optimum response in 6.3 to 22.7-kg nursery pigs. In Exp. 1, 880 pigs (440 barrows, 440 gilts) were allotted to five dietary treatments in a randomized complete block design for phase 2 (6.3-12.7 kg). Test diets involved a lysine:ME ratio below the requirement for maximum response. Treatments (1.30% Lysine) included a positive control (PC) consisting of typical nursery ingredients and four diets containing high quality porcine-derived gelatin (8.75%) and corn starch (9.89-10.0%) with added levels of crystalline tryptophan. Analyzed total T:L for the five diets were 0.16 (PC), 0.10, 0.13, 0.14, and 0.18, respectively. Quadratic improvements ($P<0.01$) in ADG, ADFI, and G:F occurred for both sexes, but maximal response was observed at 0.14 T:L for gilts and 0.18 T:L for barrows. Upon reaching an average BW of 12.7 kg, pigs on the lowest T:L treatment were removed from test and the remainder were reallotted for evaluation during phase 3 (12.7-22.7 kg). Phase 3 treatments (1.20% Lysine) resulted in analyzed T:L of 0.16 (PC), 0.11, 0.14, 0.15, and 0.17. Quadratic improvements ($P<0.01$) were observed for ADG, ADFI, and G:F, but means were similar for the 0.14, 0.15, and 0.17 T:L diets. In Exp. 2, 880 pigs were utilized from 11.2 to 23.1 kg BW to determine the effect of true ileal digestible tryptophan:lysine ratio (TID T:L) using practical corn-soybean meal diets. Pigs were allotted to treatments consisting of four TID T:L levels (0.158, 0.178, 0.198, and 0.218) and one diet containing 8.75% gelatin formulated to 0.158 TID T:L. Analyzed values were very similar to calculated values. Increases in TID T:L did not result in improvements in average daily gain, average daily feed intake, or feed efficiency. These results suggest that, with corn-soybean meal-based diets and corn-soybean meal-gelatin diets, a TID tryptophan:lysine ratio of 0.158 is adequate for phase 2 (6-13 kg) and phase 3 (13-23 kg) nursery diets.

Key Words: Pigs, Amino acids, Tryptophan

529 Evaluation of the lysine requirement for 11 to 20 kg pigs. D. C. Kendall*[1], G. L. Allee[1], J. L. Usry[2], M. M. Ward[3], and D. R. Cook[3], [1]*University of Missouri-Columbia,* [2]*Ajinomoto Heartland Inc.,* [3]*Akey.*

We have previously demonstrated (Kendall et al., 2002) that under experimental conditions, the lysine requirement of 11-25 kg pigs is 1.33% TID lys. A 16d experiment was conducted to determine the lysine requirement for 11 to 20 kg pigs (n=812, TR-4 x PIC C-22) under commercial conditions. Pigs were co-mingled from five sow farms and upon arrival were allotted by weight and sex in a randomized complete block design with 4 replicate pens per sex and housed at 22 pigs/pen (.25 m^2/pig). Pigs were fed nutritionally adequate diets prior to reaching a target weight of 11 kg. Pigs were then fed one of 5 dietary treatments. TID lysine levels of the corn-soybean meal diets were 1.05, 1.14, 1.23, 1.32, 1.41% TID lys with all diets containing the same inclusion of soybean meal (34.2%). Dietary lysine content was increased by adding Lys-HCl (0, .115, .230, .344, and .459% Lys-HCl, respectively). All diets were pelleted and formulated to be equal on a ME basis (3.42 Mcal ME/kg) with additional synthetic amino acids supplied as necessary to meet minimum amino acid ratio requirements. Pigs were given adlibitum access to feed and water. There was a linear improvement in ADG (482, 489, 518, 526, and 530 g/d, respectively; $P< .01$) and G:F (.697, .716, .759, .766. and .784, respectively; $P< .001$) with increasing lysine level. There were no differences in ADFI for the period. This experiment demonstrates that the lysine requirement for pigs from 11 to 20 kg under commercial conditions may be as high as 1.41% TID lys.

Key Words: Pigs, Lysine, Nursery

530 Evaluation of the tryptophan:lysine ratio for late finishing barrows. D. C. Kendall*, J. W. Frank, A. M. Gaines, and G. L. Allee, *University of Missouri-Columbia.*

A 28d experiment was conducted to determine the TID tryptophan:lysine (Trp:Lys) ratio for 90 to 115 kg barrows (n=82, Dekalb EB x Newsham). Pigs were allotted in a randomized complete block design and were fed one of 7 dietary treatments with 6 replicates (5 replicates for the control) and housed at 2 pigs/pen. A six point titration was constructed with a basal diet (96.1% corn, .55% TID lys, 8.68% CP) formulated to contain .06% TID trp with additional amino acids supplied from synthetic sources to meet minimum ratios (.109 Trp:Lys). The next five treatments contained increasing levels of TID trp by adding L-Typtophan at the expense of corn (.145, .182, .218, .254, and .290 Trp:Lys, respectively). A positive control corn-soybean meal diet was formulated to contain .55% TID lys, 13.6% CP and .14% TID trp (.290 Trp:Lys). All diets were formulated to be equal on a ME basis (3.40 Mcal ME/kg). Pigs were weighed bi-weekly to determine average daily gain, average daily feed intake and feed efficiency and ultrasonically scanned for tenth rib backfat and loin eye area at d0 and d28. For the overall period, there was a trend for a quadratic improvement in ADG (718, 945, 926, 925, 807, and 905 g/d, respectively; $P< .07$) and G:F (.227, .260,

.259, .258, .254, and .254, respectively; P< .08) with increasing tryptophan level, characterized by an improvement in performance from the basal diet to the .145 Trp:Lys diet and a plateau thereafter. The pigs fed the positive control diet had similar ADG (P> .10), but tended to be more efficient (.286 vs. .253; P< .07), have less accretion of BF (1.17 vs. 4.09 mm; P< .02), and greater accretion of LEA (5.15 vs. 2.36 cm^2; P< .06) than pigs fed the corn-synthetic amino acid diet at .290 Trp:Lys. This experiment demonstrates that the TID tryptophan:lysine ratio for pigs from 90 to 115 kg may be as low as .145 Trp:Lys, and that very low protein diets with high levels of synthetic amino acids may compromise feed efficiency and carcass characteristics in late finishing barrows.

Key Words: Pigs, Tryptophan, Late finishing

531 Effect of dietary protein content and phase feeding on performance and plasma urea nitrogen patterns of growing pigs. N.T. Rodgers*[1,2] and R.T. Zijlstra[1], [1]*Prairie Swine Centre Inc.*, [2]*University of Saskatchewan, Saskatoon, Canada*.

Successful N management is important for sustainable pork production. Plasma urea nitrogen (PUN) concentration is related to excess dietary AA and urinary N excretion. Either a reduction in dietary protein or phase feeding (more diets with gradually reduced AA content fed within a period) should reduce PUN, indicating reduced urinary N excretion. Two levels of dietary protein (high, avg. 19%; low, avg. 17%; 3,400 kcal DE/kg; ideal AA profile) and 3 separate phase feeding programs (2 diets each 3 wk, 3.0 and 2.2 g dig. Lys/Mcal DE; 3 diets each 2 wk, 3.0, 2.6, 2.2 g dig. Lys/Mcal DE; 6 diets each 1 wk, 3.0 down to 2.0 g dig. Lys/Mcal DE) were used as 6 treatments in a 2 x 3 factorial arrangement in 6-wk studies with 25-kg barrows. In the performance study, 180 pigs were housed 5 pigs/pen with free access to feed, for 6 pens per treatment. In the metabolism study, 36 pigs were housed in individual pens pair-fed to performance pigs, for 6 pigs per treatment. Once per wk, pig weight and feed intake were measured, blood was collected from pigs in both studies, and PUN was analyzed. Overall ADG ranged from 905 to 957 g/d in the performance study and from 790 to 889 g/d in the metabolism study, without treatment differences (P > 0.10). Overall ADFI ranged from 1.89 to 1.96 kg/d in the performance study (P > 0.10), and was 1.88 for high and 1.86 kg/d for low protein in the metabolism study (P < 0.10). Overall, PUN differed between dietary protein levels (P < 0.01) but not among phase feeding programs (P > 0.10) for both studies. Specifically, for the performance study for high versus low protein, PUN was 19% higher in wk 1 and 12% in wk 2 (P < 0.01), not different in wk 3 and 4, and 11% higher in wk 5 and 6 (P < 0.10), with similar trends for the metabolism study. In summary, dietary protein content or phase feeding did not alter performance. Results indicate that PUN may predict expected reductions in urinary N excretion for reduced dietary protein, but not for phase feeding.

Key Words: Plasma urea nitrogen, Dietary protein, Pig

532 N-acetylcysteine is a highly bioavailable precursor of cysteine for protein accretion in piglets. A. K. Shoveller*[1], J. A. Brunton[1], P. B. Pencharz[1,2], and R. O. Ball[1,2], [1]*Department of Agricultural, Food and Nutritional Science, University of Alberta, Canada*, [2]*Departments of Nutritional Science and Paediatrics, University of Toronto, Canada*.

During the neonatal period, cysteine may be an indispensable amino acid for protein accretion. In addition to its role in protein synthesis, cysteine is also a precursor for the de novo synthesized antioxidant, glutathione. Antioxidant supplementation in grower-finisher pigs has been shown to improve the physical appearance of meat. However, cysteine is relatively unstable; therefore, there are advantages to supplying alternative forms. N-acetylcysteine (NAC) may be an effective means of supplying cysteine. NAC has been shown to increase the synthesis of glutathione. The bioavailability of cysteine from N-acetylcysteine was determined in intravenously fed piglets randomized to one of four diet treatments with equal intakes of methionine (0.3 g/kg/day) and 0.2 cysteine (CON), 0 NAC (zeroNAC), 0.13 NAC (lowNAC) or 0.27 g/kg/d NAC (highNAC). Piglets (2-4 days old; 1.8 kg, n= 16) were surgically implanted with femoral venous catheters for blood sampling and jugular catheters for diet and isotope infusion. All piglets recovered on complete diets for 2 days. On day 3, the test diets were initiated and continued until day 8. Blood was sampled 6h before test diet initiation and at time 0, 6, 12, 18, 24, 36, 48, 60, 72, 84, 96, 108, and 120 h. Urine was collected on ice in 24-h periods. On day 8, 3H-phenylalanine (1 mCi/kg) and a flooding dose of cold phenylalanine (150 mmol/L, 9mL/kg) were used to measure the fractional rate of protein synthesis. Total mean weight gain was highest in highNAC and CON, lower in lowNAC and lowest in the zeroNAC group; however, these differences did not reach significance. NAC retention was not different between lowNAC and highNAC, and was 85.2% and 80.3%, respectively (pooled SD=2.19, n=8). Preliminary data indicate that the zeroNAC group had significantly lower nitrogen retention (%) than the highNAC and CON groups, and the lowNAC groups were not different from either zeroNAC or highNAC and CON. Further analysis will confirm the availability of cysteine from NAC for protein synthesis. These data suggest that NAC is a highly available precursor for cysteine when used in an intravenous solution and administered to neonatal piglets.

Key Words: N-acetylcysteine, Protein synthesis, Piglet

533 The effect of dietary protein to energy ratio on carcass composition and fillet yields of rainbow trout and Atlantic salmon. P.A. Azevedo*, S. Leeson, and D.P. Bureau, *University of Guelph, Guelph, Ontario*.

Salmonid fish species have different protein and lipid deposition patterns between various body compartments. Yield of marketable products may be different for different species and these may respond differently to changes in diet composition. This study examined the effect of dietary digestible protein to digestible energy ratio (DP/DE) on dressed carcass and fillet yield and composition of market size Atlantic salmon and rainbow trout. Four isoenergetic diets (DE = 20 MJ/kg), with different DP/DE (18, 20, 22 and 24 g/MJ) were hand-fed to near-satiety to triplicate groups of 55 rainbow trout (initial body weight, IBW = 270 g/fish) and 55 Atlantic salmon (IBW = 460 g) reared at 8.5^{o}C over 24 weeks. Dressed carcass and fillet yields were determined and samples were collected for proximate analysis. Dressed carcass yield (DCY) was significantly higher (P < 0.0001) for salmon compared to trout. Diet had no effect on DCY of trout (mean 87%), but DCY of salmon showed a linear decrease (from 91 to 88 %) with decreasing DP/DE (P < 0.05). Fillet yield (%) was not affected by species or diet and averaged 62% of carcass weight. Moisture and crude protein (CP) contents of dressed carcass were significantly higher and lipid content was lower (P < 0.05) in salmon compared to trout, but this was not affected by diet. Fillet moisture and lipid contents were significantly affected by species and diet (P < 0.05). Salmon fillets had significant higher moisture and lower lipid contents than those of trout and both contents were affected by diet (P < 0.05). There was a linear decrease (P < 0.05) of water in salmon fillet and a linear increase of lipid content (P < 0.05) in trout fillet with decreasing DP/DE ratios. CP was not affected by diet but it was higher in salmon fillet than in trout fillet (P < 0.05). The results show that isoenergetic diets with different protein contents have significant effects on carcass yield of salmon and on chemical composition of salmon and trout carcasses.

Key Words: Salmonids, Carcass composition, Diet

Physiology
Estrus Synchronization II

534 Administration of gonadotropin-releasing hormone (GnRH) on d 5 or 6 of the estrous cycle alters follicle dynamics and increases pregnancy rates in beef cattle. A. M. Arnett*, J. D. Rhinehart, J. D. Bailey, R. B. Hightshoe, and L. H. Anderson, *University of Kentucky*.

Follicle ablation prior to maternal recognition of pregnancy (d 16 - 17) can improve pregnancy rates. Two experiments were conducted to determine if administration of GnRH on d 5 or d 6 (d 0 = first observed estrus) would alter follicular growth in heifers and improve pregnancy rates. The objective of the first experiment was to characterize ovarian follicular dynamics of heifers after administration of GnRH on d 5 or d 6 of the estrous cycle. Mature crossbred heifers (n = 15) were administered