LSDs. No statistical differences between mean SF value of LD samples treated with Method I (7.32±2.91 kg) or Method II (6.98±2.93 kg) were shown. Method III resulted in higher SF values (15.20±6.22 kg). Cooking, grilling and stewing losses were different. The average of stewing loss was the highest (43.57 %), the average of grilling loss was less (26.95%), and the average of cooking loss was the least (22.r%). Slices from Methods I and II were used to determine the effect of sample location was studied within a slice. The location within a slice seemed to affect SF. As well, the effect of longitudinal location was studied within LD using slices from Methods I and II. A tendency showed that SF is decreased from caudal end to cranial end.

Key Words: Shear force, M. longissimus dorsi, Measuring methods

Nonruminant Nutrition: Energy and amino acids

549   Evaluation of the true ileal digestible (TID) lysine requirement for 7 to 14 kg pigs. A. M. Gaines*[1], D. C. Kendall[1], G. L. Allee[1], M. D. Tokach[2], S. S. Dritz[2], and J. L Usry[3], [1]University of Missouri-Columbia, Columbia, [2]Kansas State University, Manhattan, [3]Ajinomoto Heartland Inc., Chicago.

A series of experiments were conducted at three different commercial research sites in order to evaluate the true ileal digestible (TID) lysine requirement for 7 to 14 kg pigs. In Exp.1, a total of 840 pigs (PIC 337 × C22; 7.6 ± 0.13 kg) were used in a completely randomized design with 7 replicate pens/treatment and 24 pigs/pen. In Exp. 2, a total of 1,260 pigs (PIC 337 × C22; 8.5 ± 0.14 kg) were used in a completely randomized design with 6 replicate feeders/treatment and 42 pigs/feeder. In Exp. 3, a total of 770 pigs (TR-4 × C22; 7.4 ± 0.07 kg) were used in a randomized complete block design with 7 replicate pens/treatment and 22 pigs/pen. Pigs used in all three experiments were allotted to one of five dietary treatments containing 1.22, 1.32, 1.42, 1.52, and 1.62% TID lysine, respectively. Diets used in the above experiments were formulated to be isocaloric and contained the same inclusion of soybean meal (30%), fat (3%), fish meal, and blood cells. The dietary lysine content was increased by adding L-lysineHCl with additional synthetic amino acids supplied as necessary to meet the minimum amino acid profile. For Exp.1, increasing dietary lysine increased (linear, P < 0.01; quadratic, P = 0.01) ADG (409, 422, 463, 449, and 440 g/d) and improved (linear, P < 0.001; quadratic, P = 0.001) G/F (0.756, 0.803, 0.832, 0.793, and 0.823). For Exp. 2, increasing dietary lysine increased (linear, P = 0.001; quadratic, P = 0.02) ADG (350, 386, 400, 409, and 413 g/d) and improved (linear, P < 0.001; quadratic, P < 0.01) G/F (0.673, 0.737, 0.753, 0.765, and 0.775). For Exp. 3, increasing dietary lysine increased (quadratic, P = 0.05) ADG (409, 427, 427, 422, and 409 g/d) and improved (linear, P < 0.001; quadratic, P < 0.01) G/F (0.752, 0.790, 0.809, 0.837, and 0.826). Results from these experiments indicate that the TID lysine requirement for 7 to 14 kg pigs may be as high as 1.42%.

Key Words: Lysine, Pigs, Growth

550   Effects of lysine source on growth performance of 11 to 25 kg pigs. D. C. Kendall*[1], G. L. Allee[1], G. Gourley[2], D. R. Cook[3], and J. L. Usry[4], [1]University of Missouri-Columbia, [2]Swine Graphics Enterprises, [3]North American Nutrition Companies, Inc., [4]Ajinimoto Heartland Inc..

Two experiments were conducted to determine effects of high synthetic amino acid inclusion on growth performance of 11 to 25 kg pigs. Upon placement into the nursery, pigs were allotted by sex in a completely randomized design with three replicate pens per sex and housed at 25 pigs/pen (n=750, Exp. 1) or four replicate pens per sex and housed at 22 pigs/pen (n=880, Exp. 2). Exp. 1 was from 11 to 29 kg and lasted 28 d while Exp. 2 was a 21 d experiment from 11 to 22 kg. The two experiments were conducted at different commercial nurseries with pigs fed nutritionally adequate diets prior to reaching a target weight of 11 kg. Both experiments utilized 5 dietary treatments differing in the inclusion of Lys-HCl (0, 0.12, 0.24, 0.36, and 0.48% Lys-HCl) with all diets containing the same level of lysine (1.32% true ileal digestible [TID] Lys) and energy (3.42 Mcal ME/kg). Dietary lysine content was maintained by adding soybean meal (45, 41.25, 37.5, 33.75, and 30.0%). The 1.32% TID Lys level was determined as the lysine requirement in both facilities from previous experimental results. Additional synthetic amino acids were supplied as necessary to meet minimum amino acid ratio requirements. In Exp. 1, no differences existed for ADG (620, 660, 651, 623, and 640 g/d, respectively), ADFI, or G:F (0.714, 0.727, 0.720, 0.730, and 0.725, respectively) between the dietary treatments. Likewise, in Exp. 2, no differences were detected for ADG (495, 485, 507, 497, and 502 g/d, respectively), ADFI, or G:F (0.783, 0.776, 0.773, 0.784, and 0.777, respectively). These experiments demonstrate that at least 0.48% L-Lysine HCl can be supplemented in diets for 11 to 25 kg pigs, as long as minimum ideal amino acid ratios are maintained.

Key Words: Pigs, Lysine, Nursery

551   Estimation of the ideal ratio of sulfur amino acids:lysine in diets for nursery pigs weighing 11-22 kg. A. M. Gaines*[1], D. C. Kendall[1], R. W. Fent[1], J. W. Frank[1], G. F. Yi[1], B. W. Ratliff[1], G. L. Allee[1], and C. D. Knight[2], [1]University of Missouri-Columbia, [2]Novus International, St. Louis, MO.

Two experiments were conducted to evaluate the ideal ratio of sulfur amino acids:lysine (SAA:LYS) for late nursery pigs using two sources of supplemental methionine (DL-methionine vs. Alimet®). For Exp.1, a total of 330 nursery pigs (TR4 × C22; 11.4 ± 0.10 kg) were allotted to one of nine dietary treatments in a randomized complete block design with six replicate pens per treatment. The control diet (Diet 1) was formulated to contain 1.15% true ileal digestible lysine (TID) with no supplemental Alimet® or DL-methionine (49% SAA:LYS). Diets 2-9 consisted of the control diet supplemented with four levels of DL-methionine or Alimet® that corresponded to SAA:LYS ratios of 54, 59, 64, and 69%, respectively. For Exp. 2, a total of 341 nursery pigs (Genetiporc; 12.8 ± 0.56 kg) were allotted to one of six dietary treatments in a randomized complete block design with six replicate pens per treatment. The control diet (Diet 1) was formulated to contain 1.05% TID lysine with no supplemental DL-methionine (49% SAA:LYS). Diets 2-5 consisted of the control diet supplemented with four levels of DL-methionine that corresponded to SAA:LYS ratios of 54, 59, 64, and 69%, respectively. To evaluate the effect of methionine source on growth performance, a 59% SAA:LYS diet was also formulated using Alimet®. In Exp.1, increasing the SAA:LYS ratio increased (quadratic, P = 0.09) ADG (472, 500, 509, 500, and 495 g/d) and improved (quadratic, P = 0.02) G/F (0.627, 0.650, 0.669, 0.677, and 0.663). There was no effect of methionine source (P > 0.34) and (or) methionine source × SAA:LYS interactions (P > 0.89) for ADG, ADFI, or G/F (Diets 2-9). In Exp. 2, increasing the SAA:LYS ratio increased (quadratic, P = 0.05) ADG (605, 642, 631, 636, and 619 g/d) and improved (linear, P = 0.01; quadratic, P = 0.03) G/F (0.598, 0.617, 0.613, 0.620, and 0.616). There was no effect of methionine source on ADG (P = 0.16) or G/F (P = 0.28). Results from these two studies indicate that the ideal ratio of SAA:LYS is as high as 59.0%, regardless of methionine source.

Key Words: Sulfur amino acids, Pigs, Growth

552   Determination of the TID tryptophan:lysine ratio for 90 kg barrows. D. C. Kendall*[1], B. J. Kerr[2], R. D. Boyd[3], J. W. Frank[1], A. M. Gaines[1], B. Ratliff[1], R. W. Fent[1], and G. L. Allee[1], [1]University of Missouri-Columbia, [2]USDA-ARS-MWA-SOMMRU, Ames, IA, [3]The Hanor Company, Spring Green, WS.

A 29 d experiment was conducted to determine the TID tryptophan:lysine (Trp:Lys) ratio for 91 to 124 kg barrows (n=210, TR4 x PIC C-22). Pigs were allotted in a completely randomized design and fed one of five dietary treatments with six replicates of seven pigs per pen. A four point titration curve was constructed with a basal diet (0.55% TID lys, 3.47 Mcal ME/kg, 9.3% CP) formulated to contain 0.072% TID Trp (0.130 Trp:Lys). Additional amino acids were supplied from synthetic sources to meet minimum ratios. L-Trp was added at the expense of corn, creating the three other Trp:Lys treatments (0.165, 0.200, and 0.235 Trp:Lys). A control corn-soybean meal diet was formulated to contain 0.55% TID lys, 3.47 Mcal ME/kg, 11.7% CP, and 0.110% TID Trp (0.200 Trp:Lys). Blood samples were collected from four pigs/pen at d 0 and d 29 for determination of blood urea nitrogen (BUN). A linear increase in ADG (0.986, 1.11, 1.12, and 1.16 kg/day, respectively; P< 0.001) and ADFI (P< 0.01) was observed with increasing Trp:Lys for the 29 d trial. There were quadratic improvements in d 29 BW (P< 0.06) and G:F (0.304, 0.327, 0.327, and 0.330, respectively;

P< 0.05) with increasing Trp:Lys. The change in BUN level from d 0 to d 29 decreased quadratically (P< .09) with increasing Trp:Lys. Pigs fed the 0.165 Trp:Lys diet had greater d 29 BW, ADG, G:F, and lower BUN levels than pigs fed the basal diet (P< 0.05). However, the 0.165 Trp:Lys diet did not differ from the 0.200 and 0.235 Trp:Lys diets for any criterion measured. Pigs fed the control diet had similar ADG and G:F (0.335 vs. 0.327) compared to pigs fed the 0.200 Trp:Lys diet, but d 29 BUN was greater (P< 0.001). This experiment demonstrates that a TID tryptophan:lysine ratio of .165 appears adequate in maintaining performance for pigs from 91 to 124 kg.

Key Words: Pigs, Tryptophan, Growth

553   A meta-analysis to estimate the optimum threonine to lysine ratio in growing pigs. J. van Milgen*[1] and L. Le Bellego[2], [1]*INRA-UMRVP, St-Gilles, France,* [2]*Ajinomoto Eurolysine, Paris, France.*

A meta-analysis was performed using data from widely different origin in order to estimate the optimum threonine (thr) to lysine (lys) ratio in growing pigs. Data from 22 different studies were used including those for piglets, growing and finishing pigs. All studies concerned growth trials in which different levels of thr were used. The thr to lys ratio was expressed on a standardized ileal digestibility basis. If this information was not reported, it was calculated from the reported feed ingredients using table values (AmiPig). The experimental unit used in the meta-analysis was the average response criterion (i.e., average daily gain (ADG) or gain to feed (G/F) ratio) for each treatment within a study. A total of 99 responses were obtained. Data were analyzed through non-linear regression of the response criterion on the thr to lys ratio using a generic response model and a fixed study-effect (Y_i) indicative of the maximum performance within each study (i.e., $Y = Y_i \times$ (generic model)). The generic model was either a linear-plateau (LP) or a curvilinear-plateau (CLP) model parameterized to have a maximum value of 1. Data were analyzed using the NLIN-procedure of SAS. Maximum ADG within a study ranged from 320 to 1000 g/d and maximum G/F within a study ranged from 290 to 690 g/kg. The thr to lys ratio that maximized the response criterion (i.e., ADG or G/F) averaged 61% for the LP model and 70% for the CLP model. However, the interpretation of these values is different. The breakpoint for the LP model corresponds to a minimum thr to lys ratio; a 1%-point reduction of the thr to lys ratio below the breakpoint reduced ADG by .94%. In contrast, the optimum thr to lys ratio for the CLP model corresponds to a safe ratio as a small deviation from the optimum only marginally affects performance. In a subsequent analysis, the optimum thr to lys ratio was allowed to vary linearly with body weight. Using the LP model, the optimum thr to lys ratio increased from 58% at 15 kg BW to 65% at 110 kg BW. For the CLP model, these values were 66 and 73%, respectively. For most of the studies concerned, lys may not have been limiting protein deposition throughout the experiment. Consequently, 65% appears to be the minimum standardized ileal thr to lys ratio in growing pigs.

Key Words: Pigs, Threonine, Requirements

554   Prediction of the energy value of corn from the dietary composition in piglets. J. Noblet*[1] and M. Champion[2], [1]*INRA, UMRVP, Saint Gilles, France,* [2]*Limagrain Genetics, Chappes, France.*

The energy value of ingredients for swine depends mainly on their chemical composition. Dietary fibre (DF) contributes to reduction of energy concentration whereas fat increases energy content. For corn, both constituents can vary largely and, from a prospective point of view, it is important to predict the energy value of any future type of corn. The objective of the trial was then to propose equations predicting the energy content of corn from its chemical composition. For this purpose, the energy digestibility and the DE content of 11 different corns were measured in piglets according to the difference method. The inclusion rate of the corns was 35% and the basal diet contained wheat, barley, corn, soybean meal and fish meal. All diets were pelleted and fed for 16 days; excreta were collected over the last 9 days. Mean BW of the piglets was 17 kg. On average, the 11 corns contained (% of DM) 1.6% ash, 11.9% CP, 5.2% fat, 66.9% starch (ST), 2.5% sugars (SU), 3.0% ADF and 11.8% DF (DM - (ash + CP + fat + ST + SU)); the corresponding values ranged between 1.4 and 2.1%, 7.8 and 17.9%, 3.5 and 8.5%, 45.6 and 74.0%, 1.8 and 3.3%, 2.1 to 7.5%, and 9.0 and 27.6%, respectively. The gross energy content averaged 19.07 MJ/kg DM (range: 18.41 to 19.74 MJ/kg DM). The energy digestibility and the DE content

of the 11 corns averaged 88.0% (range: 79.4 to 90.3%) and 16.78 MJ/kg DM (range: 15.52 to 17.52 MJ/kg DM). According to a multiple regression model (without intercept) accounting for the total OM in corn, the calculated gross energy content of CP, fat, ST+SU and DF were 24.0, 39.8, 17.3, and 18.0 kJ/g, respectively (RSD of the model: 0.09 MJ/kg DM). The corresponding values for DE content were 18.9, 30.0, 17.2, and 8.6 kJ/g, respectively (RSD of the model: 0.26 kJ/kg DM). The average digestibilities of energy of CP, fat, ST+SU and DF in corn were then 79%, 75%, 99%, and 47%, respectively. A more simple but less precise prediction equation of corn DE would be: DE (MJ/kg DM) = 16.82 + 14.76 x Fat (g/g) + 26.76 x ADF(g/g) (RSD: 0.31 MJ/kg DM). In conclusion, this study allows estimating variation in DE content of corn according to changes in fat or DF content when fed, as pellets, to piglets. Results can be extrapolated to growing pigs.

Key Words: Pig, Corn, Energy value

555   Effect of pelleting and body weight on digestibility of energy and fat of two corns in pigs. J. Noblet*[1] and M. Champion[2], [1]*INRA, UMRVP, Saint Gilles, France,* [2]*Limagrain Genetics, Chappes, France.*

The energy value of ingredients for swine depends mainly on their chemical composition, the applied technological treatment and the BW of animals. The objective of trial 1 was to estimate the nutrients and energy digestibilities in growing pigs of two samples of corn (corn 1 and corn 2) according to two preparation technologies. For this purpose, a corn-soybean meal basal diet and two diets containing 65% of the basal diet and 35% of either corn 1 or corn 2 were fed for 3 wk to pigs weighing initially 55 kg (4/treatment), either as mash feed or as pellets. Excreta were collected for the last 10 d; average BW was then 61 kg. The energy and nutrients digestibilities of the corn samples were calculated according to the difference method. Corn 1 had a conventional composition (% of DM): 1.5% ash, 7.8% CP, 4.3% fat and 73.4% starch. The corresponding values for corn 2 were 1.6%, 9.5%, 8.2% and 67.3%, respectively. In combination with its higher fat content, the gross energy content of corn 2 was higher (19.57 vs 18.79 kJ/g DM for corn 1). Pelleting of diets improved (P<.01) fecal digestibility of fat (77 vs 61%) and energy (90.3 vs 88.4%) and the mean DE content of the three diets was 2% higher after pelleting. The energy digestibility of the corn samples was also improved by pelleting: 90.0 vs 88.0% for corn 1, 90.5 vs 88.0% for corn 2. The corresponding DE values were 16.91 vs 16.53 MJ/kg DM and 17.70 vs 17.21 MJ/kg DM. The increased energy value of corn after pelleting was mainly due to the improved digestibility of the fat fraction: 75 vs 54% for corn 1, 84 vs 65% for corn 2. In trial 2, a basal diet containing wheat, barley, corn, fish meal and soybean meal and two diets with 65% of the basal diet and 35% of either corn 1 or corn 2 were fed as pellets to piglets (4/treatment) for 16 d and their feces were collected for nine days at a mean BW of 18 kg. The energy digestibility was 90.3 and 89.5% for corn 1 and corn 2, respectively; the corresponding DE values were 16.96 and 17.52 MJ/kg DM. Fat digestibility averaged 77% for both corns. In conclusion, the DE content of corn depends mainly on its fat content and is equivalent in piglets and growing pigs, at least as pellets. Pelleting improves fat digestibility and the subsequent energy values of corn.

Key Words: Pig, Corn, Energy Value

556   Effect of high ambient temperature and feeding level on fatty acid deposition in growing pigs. M. Kloareg, L. Le Bellego, J. Mourot, J. Noblet, and J. van Milgen*, *INRA-UMRVP, St-Gilles, France.*

Predicting aspects of pork quality becomes increasingly important from both a nutritional and technological point of view. However, little information is available concerning the quantitative relation between nutrient intake and fatty acid deposition at the whole animal level. Eight blocks of five littermate barrows were used in a comparative slaughter trial to determine the effect of feeding level and ambient temperature on fatty acid (FA) deposition. At 24 kg BW, one pig from each litter was slaughtered to determine the initial FA composition. The other littermates were assigned to one of four feeding levels (100%, 90%, 80%, and 70% of ad libitum intake) and were given a diet based on wheat, corn, and soybean meal containing 3.1% lipid and 1.9% FA (of which 16% palmitic acid (C16:0), 2% stearic acid (C18:0), 21% oleic acid (C18:1), 58% linoleic acid (C18:2), and 3% linolenic acid (C18:3)). Pigs were housed individually and the temperature for each block was maintained at either 23 or 30C. At 65 kg, pigs were slaughtered and the lipid and FA

composition in the empty body was determined. Approximately 77% of the estimated digested C18:2 was deposited as-is versus 55% for C18:3. Although the complement can be oxidized or used for synthesis of other FA, 80% of the digested ω-6 FA and 55% of the ω-3 FA were deposited. For the non-essential FA, deposition exceeded intake of digestible FA nine to sixty-fold. Based on the assumption that 80% of the digestible non-essential dietary FA were deposited, the average composition of *de novo* synthesized FA corresponded to 1.7, 30.3, 2.4, 19.7 and 45.9% for myristic acid (C14:0), C16:0, palmitoleic acid (C16:1), C18:0 and C18:1, respectively. A data analysis model was developed based on the conversions between *de novo* synthesized FA. At 23C and for ad libitum feeding, 33% of C16:0 was deposited, 1.7% shortened to C14:0, 63% elongated to C18:0, and 2.8% unsaturated to C16:1. Twenty-eight percent of C18:0 (synthesized from C16:0) was deposited and 72% unsaturated to C18:1. At 30C, C18:0 desaturation was reduced by 3.5%-point. Feed intake and temperature independently affected elongation of C16:0. A reduction in feed intake increased the elongation rate whereas the increase in temperature reduced the elongation rate.

Key Words: Pigs, Fatty acids, Models

557   Partitioning of Metabolizable Energy for Maintenance and Growth by Growing Salmonids using a Factorial Approach: Species, Size/age and Diet Effects. P. A. Azevedo*[1], S. Leeson[1], C. Y. Cho[1], S. Birkett[1], H. Bayley[2], and D. P. Bureau[1], [1]*Department of Animal and Poultry Science, University of Guelph, Canada*, [2]*Department of Human Biology and Nutritional Sciences, University of Guelph, Canada.*

Efficiency of metabolizable energy (ME) utilization by juvenile lake trout (body weight, BW = 47 - 390 g) and Atlantic salmon (BW = 24 - 355 g) and post-juvenile rainbow trout (BW = 268 - 1547 g) and Atlantic salmon (BW = 456 - 1690 g) was investigated using a factorial approach. Four isoenergetic diets (estimated digestible energy, DE = 20 MJ/kg), with different digestible protein (DP)/DE ratios (18, 20, 22 and 24 g/MJ) were hand fed to near-satiety. Multiple fish carcass sampling over various time intervals was conducted to determine recovered energy (RE, kJ) and RE as protein (Pd, kJ) and RE as fat (Ld, kJ) over time. A digestibility trial (BW = 24 - 200 g) was conducted to estimate DE and ME for each diet and species. Maintenance energy requirements (MEm) and efficiency of ME utilization for growth (k_g) were estimated by linear regression. MEm was expressed as an allometric function of BW ($kg^{0.8}$). Covariance analysis was conducted on the residuals of the linear model to test for Diet, Species and Species x Diet interaction. The slope (k_g) of the linear regression of RE ($kJ/kg^{0.8}$ per day) *vs.* ME ($kJ/kg^{0.8}$ per day) was 0.66. This slope was not affected by dietary DP/DE ratio but it was significantly different among species/age combinations. The k_g was significantly higher for the juvenile lake trout ($k_g = 0.67$) and juvenile Atlantic salmon ($k_g = 0.68$) compared to the post- juvenile rainbow trout ($k_g = 0.52$). Underestimation of DE, and consequently ME, for post-juvenile Atlantic salmon is likely the reason for the surprisingly high k_g of 0.78. MEm was estimated for each treatment group by extrapolating the linear regression equation to zero RE. MEm were significantly different among species/age combinations but were not affected by diet. Furthermore the effect of Species x Diet interaction was not significant on either MEm or k_g. Multiple linear regression was used to estimate simultaneously the efficiency of ME utilization for protein deposition ($k_p = 0.45$, species effect, P< 0.05), and for fat deposition ($k_f >1$ and unrealistic), despite a Pd *vs.* Ld correlation of 0.67. Dietary DP/DE ratio had no effect on partitioning of ME utilization. However, partitioning of ME utilization was species specific and size/age dependent.

Key Words: Maintenance, Cost of growth, Salmonids

558   Effect of betaine on energy partitioning in growing pigs. J. van Milgen*, J. Noblet, and S. Dubois, *INRA-UMRVP, St-Gilles, France.*

Seven littermate barrows, initially weighing 50 kg, were used to test the effect of betaine on energy partitioning. Pigs received a corn - soybean diet supplemented with lysine, tryptophan and a vitamins and minerals mixture without choline. Each littermate received either this standard diet or the standard diet to which 1 g/kg of betaine was added. Pigs were adapted to the diet and housing conditions during two weeks prior to the start of the measurements. Both littermates received the same quantity of feed (distributed three times daily) at approximately 90% of ad libitum feed intake. Water was available ad libitum and temperature

was maintained at 24C. The experiment lasted ten days (starting at approximately 60 kg) during which fecal digestibility (10 d), the nitrogen balance (10 d) and the energy balance (indirect calorimetry; 6 d) were measured. Energy retention was calculated as the difference between ME intake and heat production (HP). Lipid retention was estimated by difference from energy retention and energy retained as protein. Components of HP were estimated by regression of HP on estimators of physical activity and feed consumption. Fasting HP was measured for one day after the energy balance period. Data were analyzed through analysis of variance using litter and betaine as main factors. Weight gain and N balance during the collection period averaged 950 and 27.4 g/d, respectively, and were not affected by betaine. Digestive utilization of energy and nutrients was equivalent in both treatments. None of the response criteria for energy utilization was affected by the addition of betaine ($P>.10$). The ME intake averaged 2451 kJ/(kg BW)$^{.60}$/d. Heat production averaged 1266 kJ/(kg BW)$^{.60}$/d and was repartitioned between fasting HP (745 kJ/(kg BW)$^{.60}$/d or 59% of HP), thermic effect of feeding (27% of HP; 14% of ME intake) and HP due to physical activity (13% of HP; 7% of ME intake). On average, 1185 kJ/(kg BW)$^{.60}$/d was retained, 28% of which as protein and 72% as lipid. The respiratory quotient averaged 1.12. Under these experimental conditions, the addition of betaine to the diet did not affect the partitioning of energy.

Key Words: Pigs, Betaine, Energy partitioning

559   Quantitative relationship between mitochondrial bioenergetics and efficiency of animal growth. T. R. Lutz* and T. S. Stahly, *Iowa State University, Ames.*

Variation in muscle mitochondria energy production among animals from a single strain, gender and rearing environment was quantified and the effects of these differences on the efficiency and rate of body growth were evaluated. Forty-three male Sprague Dawley rats, initially weighing 54 grams, were individually penned and allowed to consume a nutritionally adequate diet ad libitum for 21 ± 2 days. Body weight gains, feed intakes and feed wastage were quantified and mitochondria from the gastrocnemius muscle were isolated and mitochondrial protein content and State 4 (proton leak-dependent respiration) and State 3 (maximum rate of respiration) rates per unit of mitochondrial protein were determined. The mitochondrial RCR (ratio State3/State4), a measure of mitochondrial metabolic efficiency, also was calculated. Measures of mitochondrial energy production in the gastrocnemius muscle were correlated with the efficiency of whole body feed utilization. Specifically, lower rates of mitochondrial proton leak-dependent respiration (r = .42, P<.01) or improved mitochondrial metabolic efficiencies (r = .33, P<.05) were associated with improved BW gain/feed ratios. In addition, rats with a lower muscle mitochondrial protein content exhibited improved efficiencies of feed utilization (r = .43, P<.01) and improved rates of growth (r = .31, P<.05). Body growth rates were not associated with mitochondrial State 3 and State 4 oxygen consumption rates or RCR. Based on multiple regression analysis, differences among animals in mitochondria protein content (SD= 0.6) and proton leak-dependent respiration (SD= 4) equivalent to one SD from the population mean were associated (r^2= .33, P<.01) with additive changes in body weight gain/feed (g/g) ratios of .024 and .024, respectively. These additive shifts in efficiency of feed utilization represent a 10% change among the two animal subpopulations. These data establish that the efficiency of mitochondrial energy production and mitochondrial protein content in skeletal muscle influence efficiency of animal growth.

Key Words: Mitochondria, Proton leak, Energetic efficiency

560   Effect of body weight and dietary protein level on heat production and energy utilization in growing pigs. J. Noblet*[1], P. Dimon[1], J. van Milgen[1], S. Dubois[1], L. Le Bellego[2], and M. Rademacher[3], [1]*INRA, UMRVP, Saint Gilles, France,* [2]*Ajinomoto Eurolysine, Paris, France,* [3]*Degussa AG, Hanau, Germany.*

A conventional (NP) or a low-protein diet (LP) were fed to growing pigs weighing 27 kg, 57 kg and 89 kg (stages 1, 2 and 3, respectively) to study the effect of a reduction in dietary CP level on heat production (HP) and energy gain according to stage of growth. The difference in dietary CP level between diets NP and LP was about 4.5 points but both diets provided equivalent levels of essential amino acids. The absolute levels of CP (21.9, 19.4 and 17.4% at stages 1, 2 and 3, respectively for the NP diets) and essential amino acids (1.05, 0.88 and 0.72 g digestible lysine/MJ NE) were adapted to each growth stage; ratios between essential amino acids corresponded to the ideal protein profile. Diets were

based on wheat, corn, and soybean meal and variation in CP content was achieved by substituting soybean protein isolate by corn starch and free amino acids (lysine, methionine, tryptophan, threonine, isoleucine and valine). Six blocks of two littermate barrows were used at each stage. Littermates received either the NP or the LP diet. Performance, nutrient digestibility, energy, protein and fat balance, and components of HP (indirect calorimetry) were measured for 10 d in pigs housed individually at 24C and fed four meals daily at about 90% of their ad libitum intake; feed intakes were similar within a litter. Performance was not affected (P>.05) by diet characteristics (915 g/d for ADG and 2.17 for FCR) and differed between stages. Nitrogen gain was lower (P<.05) at stage 1 (24.2 g/d) than at stages 2 and 3 (26.6 g/d) and lower for diet LP (24.5 g/d) than for diet NP (27.0 g/d). When adjusted for identi-cal ME intake (2570 kJ/(kg BW)$^{.60}$/d) and physical activity, HP was higher (P<.01) for diet NP (1402 vs 1350 kJ/(kg BW)$^{.60}$/d for diet LP) and at stages 2 and 3 (1404 vs 1320 kJ/(kg BW)$^{.60}$/d at stage 1). The lower HP at stage 1 was due to a lower (P<.01) fasting HP (661 vs 766 kJ/(kg BW$^{.60}$/d at stages 2 and 3). The HP difference between diets was not affected by stage of growth and is equivalent to the difference in thermic effect of feed between diets (17.9 and 16.0% of ME for diets NP and LP, respectively). The activity related HP represented 8.1% of ME intake. These results confirm the interest of using a NE system as a basis for formulation of pig feeds.

Physiology: Uterus, gamete, embryo, and growth

561   Sheep oviductal secretory glycoprotein and mRNA expression in prepubertal ewe lambs, and mature ewes after natural or progestin-synchronized estrus. J. G. Berardinelli*[1] and D. Burgess[1], [1]*Montana State University, Bozeman.*

Expression of sheep oviductal secretory glycoprotein (sOSP) and mRNA in the ampulla (AMP) and isthmus (IST) were evaluated in prepubertal ewe lambs (PP; n = 5), mature ewes that exhibited natural estrus (MNE; n = 4), and mature ewes synchronized with progestin (MSE; n = 5). Salpingectomies were preformed aseptically 24 h after estrus for MNE and MSE ewes, and 18 h after feed and water removal for PP ewes. Utero-tubal, isthmic-ampullary, and ampullary-infundibular junctions of each oviduct were ligated to prevent fluid transfer among segments. Sections (4 mm) of mid-ampulla and mid-isthmus of one oviduct were frozen immediately in OCT for immunocytochemical analyses. Mucosa of the AMP and IST of the other oviduct was scraped with sterile mRNAase-free slides. Scrapings were placed into 1 mL of TRIzol® reagent and flash frozen in liquid N_2 for mRNA expression analysis. Sections (5 μm) of AMP and IST were treated with a primary rabbit antibody specific for sOSP, followed by a FITC donkey anti-rabbit second antibody, and visualized by fluorescence microscopy. Real-time RT-PCR, using forward and reverse primers for sOSP, was used to determine the presence of sOSP mRNA in each segment. Immunofluorescent staining showed that sOSP was present at the mucosa-lumen interface of the AMP and IST in 100% of PP, MNE, and MSE ewes. Relative fluorescent density (RFD; 0 = black; 3 = intense green) of AMP and IST sections did not differ (P < 0.05) among PP, MNE, or MSE ewes. RFD was greater (P < 0.05) in the AMP than in the IST. Sheep OSP mRNA was present in the AMP of every ewe (100%). There was no indication of mRNA expression for sOSP in the IST of any ewe (0%). We conclude that sOSP is present in the muscosa of the AMP and IST; however, sOSP mRNA is expressed only in cells of the AMP. Presence of sOSP in the AMP and IST, and mRNA for sOSP in the AMP was not affected by progestin synchronization or sexual development in sheep.

562   Mifepristone treatment on d 2 of pregnancy decreases uterine capacity in swine. J. L. Vallet* and R. K. Christenson, *USDA, ARS, US Meat Animal Research Center.*

Progesterone treatment on d 2 and 3 of pregnancy accelerated conceptus development and uterine protein secretion and decreased uterine capacity. By contrast, treatment with mifepristone (RU486), a progesterone antagonist, on d 2 of pregnancy decreased uterine protein secretion and conceptus development. The objective of the following experiment was to determine the effect of RU486 on uterine capacity. Gilts were unilaterally ovariohysterectomized (UHO) at 160 d of age, observed for estrus starting at 200 d of age, and mated after at least one estrous cycle of normal length (17 to 23 d). Gilts then received either corn oil (CO, n = 47) or RU486 (400 mg in CO, n = 44) intramuscularly on d 2 of pregnancy. Gilts were slaughtered on d 105 and blood was collected from each fetus to measure fetal hematocrit. Each fetus, its associated placenta and each fetal heart, liver, and brain was weighed. The number of gilts remaining pregnant, mean fetal hematocrit and mean fetal heart and brain weight did not differ between treatments. Uterine capacity (litter size in UHO gilts) was significantly less (4.7 ± 0.4 and 7.3 ± 0.3, respectively; P< 0.01) in RU486-treated gilts than in CO gilts. Fetal weights (907 ± 18 and 859 ± 17, P = 0.05) and fetal liver weights (23.9 ± 0.8 and 21.5 ± 0.8, P < 0.05) were greater in fetuses of RU486-treated gilts compared to CO gilts. The number of fetuses weighing >900 g (2.5 ± 0.3 and 2.7 ± 0.3) and the number of placentas weighing >225 g (2.0 ± 0.3 and 2.2 ± 0.3, respectively) did not differ between treatments. In contrast, the number of fetuses weighing <900 g (2.2 ± 0.4 and 4.6 ± 0.4) and the number of placentas weighing <225 g (2.8 ± 0.4 and 5.0 ± 0.4, respectively) were less (P < 0.01) in RU486-treated gilts than in CO gilts. Thus, RU486 decreased uterine capacity, primarily by reducing the number of smaller conceptuses at d 105 of gestation. These results, combined with previous results, suggest that optimal uterine capacity is associated with an optimal progesterone concentration on d 2 and 3 of pregnancy.

563   Molecular cloning and endometrial expression of porcine high density lipoprotein receptor SR-BI during the estrous cycle and early pregnancy. J. G. Kim*, J. L. Vallet, and R. K. Christenson, [1]*USDA, ARS, U.S. Meat Animal Research Center, Clay Center, NE.*

Rapid development of the placenta and fetus is associated with elevated levels of circulating high density lipoprotein (HDL) in humans. HDL receptor SR-BI (CD36L1) mediates selective cholesterol uptake and it is expressed in the human placenta. Endometrial expression of HDL receptor SR-BI mRNA has not been studied. We hypothesized that HDL receptor SR-BI may be expressed in porcine endometrium to take up maternal HDL cholesterol during early pregnancy to support endometrial development. The objectives of this study were to 1) clone and sequence the full coding region for HDL receptor SR-BI and 2) characterize SR-BI gene expression in the endometrium during the estrous cycle and early pregnancy in swine. By iterative screening of a porcine expressed sequence tag library, we obtained a clone (2601 bp, GenBank AF467889) containing the full coding region of HDL receptor SR-BI. Percent identities of porcine SR-BI amino acid sequence with bovine, human, mouse and rat SR-BI were 88, 87, 80 and 79%, respectively. Endometrial expression of SR-BI mRNA in White composite gilts (n=3 to 4) was determined by Northern blotting using total RNA from d 10, 13 and 15 cyclic and from d 10, 13, 15, 20, 30 and 40 pregnant gilts, followed by densitometry. There was an interaction (status x day) in SR-BI mRNA expression (P<0.01). In cyclic gilts, endometrial expression of SR-BI mRNA did not change between days 10 and 13, and increased (P<0.01) between d 13 (84.4±10.8 arbitrary units) and 15 (151.7±9.3). In pregnant gilts, endometrial expression of SR-BI mRNA increased (P<0.01) between d 10 (100.0±9.3) and 13 (140.5±9.3), remained elevated until d 30 (157.5±10.9), and decreased (P=0.015) on d 40 (113.4±10.8). These results show that endometrial SR-BI mRNA expression is temporally regulated during early pregnancy and the estrous cycle. This pattern of gene expression suggests that HDL receptor SR-BI plays a role in endometrial function during the estrous cycle and early pregnancy in swine.

564   Timing of dinitrophenol treatment during in vitro culture of bovine embryos. J. F. De La Torre-Sanchez* and G. E. Seidel, Jr., *Colorado State University, Fort Collins, CO USA.*

Dinitrophenol (DNP) uncouples oxidative phosphorylation (OXP) and reduces glucose oxidation in in vitro-cultured embryos. Partial inhibition of OXP by DNP is beneficial for porcine and bovine embryos around the time of compaction. In this work we evaluated effects of timing

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