

Nonruminant Nutrition: Amino Acids 2

489 Impact of sulfur amino acid intake and immune system stimulation on pathways of sulfur amino acid metabolism at transcriptional level in growing pigs. A. Rakhshandeh*¹, A. Holliss², N. A. Karrow¹, and C. F. M. de Lange¹, ¹University of Guelph, Department of Animal and Poultry Science, ²University of Guelph, Advance Analysis Centre, Guelph, Ontario, Canada.

Sulfur amino acid intake (SAA) and immune system stimulation (ISS) alter post-translational metabolism of SAA. In this study we investigated the impact of SAA intake and ISS on expression of key regulatory genes that control the pathways of SAA metabolism in different tissues of pigs. Restricted-fed barrows (BW 21.5 kg) were allotted to one of 2 levels of SAA intake (1.1 and 3.2, g/d) and injected with either saline (n = 8) or increasing amounts of *Escherichia coli* lipopolysaccharide (n = 16) every 48 h for 7 d. Pigs were then killed for the collection of liver, spleen and ileum tissues for total RNA extraction. Tissue and an internal standard (KANr) RNA were then reverse transcribed. Expression was simultaneously determined by multiplex PCR amplification of cDNA from tissues, the housekeeping gene (β -2-microglobulin) and the internal standard in the presence of their corresponding fluorescent labeled primers. The interactive effect (ISS \times SAA) resulted in upregulation of adenosylhomocysteinase (AHCY) at higher level of SAA intake in liver of ISS pigs ($P < 0.01$). No interactive effect on other studied genes was observed. Increased SAA intake upregulated cysteine dioxygenase (CDO1), 3-mercaptopyruvate sulfurtransferase (MST) and cysteine sulfinic acid decarboxylase (CSAD) in liver ($P < 0.05$). Expression of CDO1, MST and cystathionine β -synthase (CBS) in liver was upregulated by ISS. However, ISS downregulated methionine adenosyltransferase 2 (MAT2) in liver ($P < 0.05$). Expression of methionine synthase (MTR) and cystathionine γ -lyase (CTH) was not affected by the treatments. Results of gene expression in spleen and ileum are forthcoming. This study suggests that the SAA metabolism pathways are changed at transcriptional level by ISS and SAA intake.

Key Words: sulfur amino acids, immune system stimulation, gene expression, multiplex PCR

490 The effect of feeding heavy and medium weight nursery pigs increased levels of amino acids on pig performance. J. L. Pietig* and C. E. Hostetler, *South Dakota State University, Brookings*

A study was conducted to determine the effect of feeding increased levels of amino acids to nursery pigs, which were heavy and medium weight at weaning. A total of 144 (n = 144) crossbred, mixed sex pigs (21.7 d of age) was used in the study. A 3 phase feeding program was used to mimic industry practice. Treatments consisted of nursery diets with increased levels of lysine, methionine, threonine and tryptophan. The control diet was designed to meet industry standards (IS; n = 36). Dietary concentrations of the aforementioned amino acids were increased above the control diet by 10% (+10; n = 36), 20% (+20; n = 36), and 30% (+30; n = 36) using synthetic amino acids. Pigs were blocked by body weight (Heavy; 7.87 kg BW and Medium; 5.88 kg BW) at weaning. Pigs were weighed at trial initiation and at each diet change; average daily feed disappearance (ADFD) was determined for each phase. All pigs were bled on d 4, 11, and 28 after initiation of the trial for determination of plasma urea nitrogen (PUN) levels. In phase 1 there was a significant effect of treatment on ADG (0.177 vs. 0.156, 0.150, 0.144 Kg; +10 vs. IS, +30, +20 respectively; $P < 0.05$) and feed to gain efficiency (F:G; 1.31 vs. 1.19, 1.18, 1.11; +20, +30, IS, +10 respectively; $P < 0.05$). In period 2 there was an effect of treatment on ADFD (0.367 vs. 0.412,

0.418, 0.448 Kg; +30, +20, +10, +IS respectively; $P < 0.05$) and PUN levels (13.23 vs. 8.55, 8.28, 7.741; IS, +20, +30, +10 respectively; $P < 0.05$). Also, PUN levels were affected by weight (10.83 vs. 8.07; Heavy vs. Medium respectively; $P < 0.05$). In phase 3 there was no significant effect of treatment on performance or PUN levels. Over the entire trial, there was a significant effect of treatment on F:G (1.38 vs. 1.42, 1.43, 1.464; +10, +30, +20, IS; respectively; $P < 0.05$) and PUN was effected by weight (12.707 vs. 10.328; heavy vs. medium; $P < 0.05$). These results indicate that there may be benefit to feeding higher levels of amino acids to nursery pigs and that medium weight pigs may benefit from increased amino acid levels compared with heavy weight pigs.

Key Words: swine, nutrition, amino acids

491 Amino acid digestibility in heated soybean meal fed to growing pigs. J. C. González*^{1,2}, B. G. Kim², A. Lemme³, and H. H. Stein², ¹National University of Colombia, Bogota, Condinamarca, Colombia, ²University of Illinois, Urbana, ³Evonik Degussa GmbH, Rodenbacher Chaussee, Hanau, Germany.

Excessive heat treatment during processing may lead to destruction of AA and the formation of biologically unavailable AA-carbohydrate complexes (i.e., Maillard formation). The objective of the present experiment was to determine the effects of heat treatment of soybean meal (SBM) on standardized ileal digestibility (SID) of AA by growing pigs. Ten growing barrows (average initial BW: 25.3 \pm 2.04 kg) were individually fitted with a T-cannula in the distal ileum and used in the experiment. Pigs were allotted to a replicated 5 \times 5 balanced Latin square design with 5 diets and 5 periods. Four sources of SBM were prepared by 1) no heat treatment, 2) autoclaving at 125°C for 15 min, 3) autoclaving at 125°C for 30 min, or 4) oven drying at 125°C for 30 min. Four diets contained each of the 4 SBM sources as the sole source of AA. A N-free diet was used to estimate basal endogenous losses of AA. The SID of CP and all AA in SBM linearly decreased as the time of autoclaving increased from 0 to 30 min ($P < 0.01$; Table 1). Oven drying at 125°C for 30 min only tended to reduce the SID of CP and AA in this study. It is concluded that heat treatment in the form of autoclaving at 125°C impairs the digestibility of AA in SBM.

Table 1. Standardized ileal digestibility of CP and AA in soybean meal that has either not been heated, autoclaved (AC) or oven-dried (OD)¹

Item	Soybean meal				SEM	P-value
	Not heated	AC at 125°C for 15 min	AC at 125°C for 30 min	OD at 125°C for 30 min		
CP, %	93.1 ^a	88.8 ^a	84.0 ^b	91.4 ^a	1.48	< 0.01
Lys, %	93.0 ^a	89.3 ^b	84.2 ^c	91.3 ^{ab}	1.21	< 0.01
Met, %	93.2 ^a	91.1 ^a	88.3 ^b	92.4 ^a	0.91	< 0.01
Thr, %	89.2 ^a	87.1 ^{ab}	83.5 ^b	86.1 ^{ab}	1.45	< 0.01
Trp, %	90.9 ^a	88.0 ^{ab}	83.8 ^b	88.4 ^a	1.37	< 0.01

¹Each least squares means represents 10 observations.

Key Words: amino acid, digestibility, soybean meal

492 Effects of balanced protein level on growth performance and carcass composition of growing-finishing pigs. N. W. Shelton¹, R. D. Goodband¹, M. D. Tokach¹, S. S. Dritz¹, J. L. Nelssen¹, J. M. DeR-

ouchey¹, M. S. Redshaw², and J. K. Htoo*², ¹Kansas State University, Manhattan, ²Evonik Degussa GmbH, Hanau, Germany.

A total of 1,003 barrows and gilts (PIC 337; initial BW of 51.5 kg) were used in a 88-d study to determine the effects of varied levels of balanced protein (BP) on growth performance and carcass characteristics. Balanced protein refers to balancing dietary AA according to the ideal protein ratio at least for the first 4 limiting AA. In a completely randomized design, 3 corn and soybean meal-based experimental diets were tested over 2 phases, including a growing phase (d 0–28; 51–79 kg BW) and a finishing phase (d 29–88; 79–130 kg BW) using 6 replicate gilt and 7 replicate barrow pens per treatment. Dietary treatments included a low BP diet which met the NRC (1998) requirements, a diet which met Evonik Degussa (ED) recommendations, and a diet which was formulated to be 10% above the ED recommendations. Diets were formulated to contain identical net energy content. No gender × BP interactions were observed ($P > 0.30$) for any of the growth performance and carcass responses. During the growing phase, G:F improved ($P = 0.001$) and ADG tended to increase ($P = 0.07$) as the BP level increased in the diet. The greatest improvements were achieved with the highest BP level containing 0.89% standardized ileal digestible Lys. Gilts had improved ($P < 0.001$) G:F from d 0 to 28 compared with barrows. During the finishing phase, BP levels did not affect ($P > 0.05$) growth performance which may have been confounded by a relatively long duration (60 d) of the finishing phase. Over the entire 88-d period, ADG and G:F improved ($P < 0.02$) as the dietary BP levels increased. Gilts had lower ADFI and improved G:F ($P < 0.01$) than barrows during the entire period. Carcass characteristics (yield, backfat depth, loin depth, lean percentage) and income over feed cost were not affected by feeding varied levels of BP. These results suggest that today's pigs with high lean potential respond to a higher BP than current recommendations.

Key Words: balanced protein, lysine, pig

493 Effect of tryptophan level on growth performance in 10- to 50-kg pigs. D. Renaudeau*¹, M. Giorgi¹, C. Anais¹, and Y. Primot², ¹Institut National de la Recherche Agronomique, UR143, Petit-Bourg, French West Indies, France, ²Ajinomoto Eurolysine, Paris, France.

The effect of dietary tryptophan (Trp) content and pig density were tested between 10 to 50 kg BW on a total of 80 Large White pigs (40 females and 40 barrows) as a complete randomized block design in a 2 × 2 factorial arrangement (2 replicates/treatment). Pigs were randomly assigned to one of 4 treatments in 8 similar pens (3 × 2 m) of 8 or 12 animals (0.75 or 0.50 pig/m²). In each pen, females and barrows were equally mixed. Dietary treatments consisted of 2 diets with different standard ileal digestible (SID) Trp content (0.19 or 0.25%), where the SID lysine content (1.06%), energy level (10.2 MJ NE/kg) and ideal AA patterns (Lys, Thr, Met, Ile, Val) were kept constant. Data were subjected to an ANOVA including the effect of diet, pig density, replicate, sex, block and interactions (GLM procedure of SAS). There were no interaction between dietary Trp content and pig density ($P > 0.05$). The average daily feed intake (ADFI) was not influenced by pig density between 10 and 25 kg (827 g/d on average; $P > 0.05$). Between 25 and 50 kg, ADFI was reduced when pig density increased from 8 to 12 pig/pen (1600 vs. 1357 g/d; $P < 0.05$) which resulted in a non-significant reduction of the average daily gain (ADG) (715 to 646 g/d; $P = 0.07$). Between 10 to 25 kg, ADFI and ADG were significantly higher in high Trp diet (863 vs. 790 g/d and 500 vs. 454 g/d; $P < 0.05$). Feed conversion ratio (FCR) was not influenced by diet and averaged 1.7 kg/kg. Between 25 to 50 kg, ADG, ADFI and FCR were not affected by diet and averaged 681 g/d, 1480 g/d and 2.3 kg/kg, respectively. The lack of effect of high dietary Trp content from 25 to 50 kg could be explained by the

fact that dietary lysine content was not limiting for growth for this BW range after 25 kg. For the whole experiment period, ADFI remained unaffected by diet ($P > 0.05$) and ADG tended to be higher in pigs fed high Trp diet (601 vs. 557 g/d; $P = 0.06$). These results suggested that a SID Trp content higher than 0.19 g/100 g or 0.18 g/100 g SID lysine is necessary to maximize growth performance in pigs especially between 10 to 25 kg BW.

Key Words: pig, amino acids, tryptophan

494 Estimation of optimum tryptophan to lysine ratio in wheat-barley or corn-soybean meal based diets for 15- to 35-kg pigs. J. K. Htoo*¹, M. Naatjes², K. H. Tölle³, and A. Susenbeth², ¹Evonik Degussa GmbH, Hanau, Germany, ²Christian-Albrechts University, Kiel, Germany, ³Training and Research Center Futterkamp, Bleken-dorf, Germany.

A 28-d dose-response assay was conducted with 880 mixed-sex pigs (Pietrain × dbNaima; initial BW of 14.4 kg) with 5 pen replicates per treatment to determine the optimum dietary standardized ileal digestible (SID) Trp:Lys ratio for 15 to 35 kg pigs fed corn-soybean meal (SBM) or wheat-barley based diets. Two Trp-deficient basal diets, based on wheat-barley or corn-SBM, were formulated, using analyzed ingredient AA contents and published SID AA values to meet requirements of AA other than Trp and Lys. The Lys level (1.05% SID Lys) was marginally limiting in all diets, which corresponds to 91% of requirement (1.15% SID Lys) recommended for the pigs used in the study. L-Trp was added to both basal diets at the expense of wheat or corn to create 7 SID Trp:Lys ratios (13.3, 14.8, 16.3, 17.8, 19.3, 20.8 and 22.3%), and a Lys-adequate diet (diet 8, equivalent to diet 7 with added L-Lys-HCl to contain 1.15% SID Lys) was also formulated as a control for both diet types. The SID Trp:Lys ratios (based on analyzed AA content) were 13.1, 14.2, 15.3, 16.4, 17.5, 18.6 and 19.7% in diets 1 to 7 of wheat-barley based diets, and 14.3, 15.4, 16.5, 17.6, 18.7, 19.8 and 20.9% in diets 1 to 7 of corn-soybean meal based diets, respectively. The ADG and FCR of pigs were improved ($P < 0.05$) with increasing Trp:Lys ratio for both wheat-barley and corn-SBM based diets. Feed intake was increased by graded level of Trp:Lys ratio in both wheat-barley ($P < 0.05$) and corn-SBM based diets ($P < 0.10$). The estimated SID Trp:Lys ratios to optimize ADG were > 19.7 and 15.9% in wheat-barley based diets, and > 20.9 and 17.8% in corn-SBM based diets based on the exponential (at 95% of plateau) and broken-line regression, respectively. The SID Trp:Lys ratios to optimize FCR were > 19.7 and 17.0% for wheat-barley based diets, and > 20.9 and 19.9% for corn-SBM based diets by using the respective exponential and broken-line models.

Key Words: lysine, ratio, tryptophan

495 Effect of lysine level and curve feeding on the performance and carcass characteristics of grow-finish pigs. K. L. Herkelman*¹, S. Kelley², S. Bailey¹, and E. Engle³, ¹Wenger's Feed Mill, Inc., Rheems, PA, ²Country View Family Farms, Lancaster, PA, ³Hatfield Quality Meats, Hatfield, PA.

An experiment was conducted to evaluate the effect of lysine level and curve feeding on the performance and carcass characteristics of grow-finish pigs. Crossbred pigs (n = 1,012; initial BW: 28.4 kg) were blocked by BW and gender and allotted to 4 treatments with 10 replicate pens/treatment and 25 or 26 pigs/pen. Treatments were arranged in a 2 × 2 factorial design with 2 levels of lysine (Control or Control + 0.1% dietary lysine in each phase) and 2 types of feeding systems (Feed Budget or Curve Feeding). The Control treatment consisted of diets containing 1.21, 1.10, 1.00, 0.86, and 0.78% dietary lysine fed in 5 phases. Pigs fed