**Table 092.**

| | SID Trp:Lys, % | | | | | | |
|---|---|---|---|---|---|---|---|
| | 14.5 | 16.5 | 18.0 | 19.5 | 21.0 | 22.5 | 24.5 |
| ADG, g | 369 ± 20.2 | 428 ± 20.2 | 442 ± 20.2 | 432 ± 20.2 | 453 ± 17.6 | 451 ± 17.6 | 435 ± 17.6 |
| G:F | 0.543 ± 0.008 | 0.582 ± 0.005 | 0.582 ± 0.005 | 0.578 ± 0.008 | 0.590 ± 0.005 | 0.584 ± 0.005 | 0.580 ± 0.008 |

For each response, the best fitting models were selected using Bayesian information criterion. Increasing Trp:Lys increased ($P < 0.004$) ADG and G:F in a quadratic manner. For ADG, the best fitting model was a QP [–317 + 7259 × (Trp:Lys) – 17,110 × (Trp:Lys)$^2$] with maximum ADG at 21.2% SID Trp:Lys and 99% of maximum ADG achieved at 19.5% SID Trp:Lys. For G:F, BLL, and BLQ models had comparable fit and estimated SID Trp:Lys requirements of 16.6 (95% CI: 16.0 to 17.3) and 17.1% (95% CI: 16.6 to 17.7), respectively. In conclusion, the SID Trp:Lys requirement for 11 to 20 kg pigs ranged from 16.6% for G:F to 21.2% for maximum ADG, with 99% of maximum ADG at 19.5% SID Trp:Lys.

**Key Words:** amino acids, pigs, tryptophan

093 **Withdrawn.**

094 **Effects of an essential oils blend on growth performance of nursery pigs.** N. Lu[1,*], M. D. Lindemann[1], J. R. Bergstrom[2], C. W. Parks[2], H. J. Monegue[1], J. H. Cho[1], *[1]University of Kentucky, Lexington, [2]DSM Nutritional Products, Parsippany, NJ.*

Three experiments were conducted to evaluate the effects of a proprietary blend of essential oils (CRINA Piglets, DSM Nutritional Products, Parsippany, NJ) on growth performance of nursery pigs. A total of 96, 48, and 48 crossbred nursery pigs with initial BW of 6.62, 7.17, and 7.10 kg were used, respectively. Pigs were blocked by initial BW and sex before randomly allotted to 4 dietary treatments in each of the 3 experiments that were conducted for 35 d using 3 diet phases (7, 14, and 14 d). The dietary treatments were: 1) basal diets with no additive [CON]; 2) CON plus carbadox at 55 ppm [MEC]; 3) CON plus CRINA Piglets at 200 ppm [CRI]; and 4) CON plus carbadox at 55 ppm and CRINA Piglets at 200 ppm [MEC + CRI]. Basal diets were formulated to contain 3335, 3344, and 3329 kcal/kg ME, and 1.62, 1.51, and 1.41% total lysine, for the 3 phases, respectively. Data were checked for normality and pooled for statistical analysis. In total, 12 replicates (pens) were used per treatment, and no experiment × treatment interactions were detected ($P > 0.26$). The 35-d ADG was 493, 514, 510, and 495 g/d for Diet 1 to 4, respectively ($P = 0.25$); the 35-d ADFI was 741, 757, 752, and 741 g/d, respectively ($P = 0.80$); and the 35-d G:F was 0.666, 0.680, 0.678, and 0.667, respectively ($P = 0.55$). The 35-d ADG response demonstrated a significant MEC × CRI interaction ($P = 0.05$), which indicated the numerical improvement of MEC and CRI might be negated by their combination. The response to both products decreased across the 3 diet phases. Compared with CON, MEC and CRI numerically increased ADG in Phase 1 by 10.43 and 12.27%, respectively (180 and 183 vs. 163 g/d); in Phase 2 by 6.28 and 3.14%, respectively (508 and 493 vs. 478 g/d); and in Phase 3 by 1.93 and 2.37%, respectively (687 and 690 vs. 674 g/d). Likewise, when comparing MEC and CRI to CON, the numerical differences in G:F were 12.40 and 4.75% in Phase 1, respectively (0.734 and 0.684 vs. 0.653); 3.00 and 0.46% in Phase 2, respectively (0.762 and 0.743 vs. 0.740); and –0.16% and 2.11% in Phase 3, respectively (0.624 and 0.639 vs. 0.625). In this study, CRI and MEC numerically improved the growth of nursery pigs in a similar manner, but the responses to each were not additive.

**Key Words:** essential oils, growth performance, nursery pigs

095 **Comparative effects of dietary Cu, Zn, essential oil, and chlortetracycline on nursery pig growth performance.** J. A. Feldpausch[1,*], J. A. De Jong[1], M. D. Tokach[1], S. S. Dritz[1], J. C. Woodworth[1], R. G. Amachawadi[1], H. M. Scott[1,2], J. L. Nelssen[1], R. D. Goodband[1], *[1]Kansas State University, Manhattan, [2]Texas A&M University, College Station.*

Weaned pigs (n = 350; PIC 1050; initially 6.05 kg) were used in a 47-d study to compare the effects of feeding antibiotic alternatives (Cu, Zn, and essential oil), alone or in combination, on nursery pig performance. Pigs were allotted to pens at weaning (d 0) and fed a common starter diet with no antimicrobial for 5 d prior to diet treatments. On d 5, pens of 5 pigs were allotted to 1 of 10 dietary treatments balanced on average pen weight in a randomized block design with 7 replications/treatment. Dietary treatments were arranged in a 2 × 2 × 2 + 2 factorial with main effects of added Cu from $CuSO_4$ (0 vs. 125 ppm Cu), added Zn from ZnO (0 vs. 3,000 ppm Zn from d 5 to 12 and 2,000 ppm Zn from d 12 to 33), and essential oil (0 vs. 0.1% Regano EX containing origanum oil; Ralco Animal Nutrition, Marshall, MN). The 2 additional treatments were subtherapeutic and therapeutic levels of chlortetracycline (CTC; 55 or 441 mg/kg). All diets contained 16.5 ppm Cu and 165 ppm of Zn from the trace mineral premix. Pigs were fed experimental diets from d 5 to 33 after weaning followed by a common corn-soybean meal based diet without any antimicrobial, essential oil, or pharmacological levels of Cu or Zn from d 33 to 47. To comply with FDA guidelines, CTC was removed on d 19 from the diet of pigs fed 441 mg/kg CTC, then added again from d 20 to 33. During the treatment period, essential oil had

no effect ($P > 0.05$) on ADG or ADFI, whereas pharmacological levels of Cu, Zn, and CTC increased ($P = 0.003$, 0.001, linear 0.028, respectively) ADG with coinciding increases ($P = 0.055$, 0.006, and linear 0.079, respectively) in ADFI. Copper, Zn, and CTC had no effect ($P > 0.05$) on G:F. Essential oil decreased ($P = 0.009$) G:F and a Cu × essential oil interaction ($P = 0.024$) was observed due to poorer-than-expected G:F of pigs when Cu was fed in combination with essential oil. The dietary treatments had minimal carryover effects on subsequent nursery pig growth performance. Overall, from d 5 to 47, Cu increased ($P = 0.018$) ADG, Zn increased ($P < 0.05$) ADG and ADFI, and essential oil tended to decrease ($P = 0.086$) overall G:F. In conclusion, increased levels of dietary Cu, Zn, or CTC improved weanling pig performance while essential oil elicited no growth performance benefits.

**Key Words:** antibiotic, essential oil, nursery pig

## 096 Effect of ractopamine and enzyme supplementation 28 days prior to marketing on growth performance of finishing pigs.

M. D. Asmus*, A. M. Jones, E. R. Otto-Tice, C. E. Vonderohe, F. A. Cabezon, A. P. Schinckel, B. T. Richert, *Purdue University, West Lafayette, IN.*

One-hundred eighty pigs (initial BW = 105.4 ± 1.29 kg) were used to evaluate the effects of 2 enzymes individually and in combination in a corn-soybean meal-cDDGS based diet on pig growth performance and feed efficiency during late finishing. Pigs were allocated in a randomized complete block design of mixed gender pens, stratified by ancestory, gender, and initial BW to 5 treatments with 6 pens/treatment and 6 pigs/pen. Dietary treatments included: 1) negative control (0.75% standardized ileal digestible [SID] Lys; NC); 2) NC + ractopamine (RAC); 3) RAC + enzyme (0.08 MU/kg β-mannanase; RENZ1); 4) RAC + enzyme (0.08 MU/kg β-glucanase + 0.10 MU/kg β-mannanase; RENZ2); 5) RAC + enzyme (0.08 MU/kg β-glucanase, 0.18 MU/kg β-mannanase; RENZ1 + 2). Treatments 2 through 5 contained 5 ppm ractopamine from d 0 to 14 and 10 ppm ractopamine from d 14 to 28. For d 0 to 14, pigs fed the RAC diet had increased ($P < 0.001$) ADG, improved feed efficiency and tended ($P < 0.06$) to have increased ADFI when compared with pigs fed the NC diet. Pigs fed RENZ1 had increased ($P < 0.05$) ADG, and improved ($P < 0.02$) G:F, while pigs fed RENZ2 tended ($P < 0.08$) to have reduced G:F compared with pigs fed RAC. Pigs fed RAC from d 14 to 28 had increased ($P < 0.05$) ADG, ADFI, and improved G:F compared with NC. Feeding RENZ1 or RENZ2 had no impact ($P > 0.61$) on ADG, ADFI, or G:F from d 14 to 28 compared with RAC fed pigs. For the overall period d 0 to 28, pigs fed RAC diets had increased ($P < 0.04$) ADG and ADFI with improved ($P < 0.001$) feed efficiency compared with NC. Pigs fed RENZ1 had increased ($P < 0.01$) ADG and improved ($P < 0.02$) feed efficiency while pigs fed RENZ2 had no improvement ($P > 0.21$) in measured response criteria compared with pigs fed RAC. In conclusion, pigs fed the RAC diet had increased ADG and ADFI with improved feed efficiency throughout the trial. Pigs fed RENZ1 had increased ADG driven by improved feed efficiency compared with pigs fed RAC. This study indicates the combination of RAC and β-mannanase has the potential to improve late finishing performance.

**Table 096.**

| | Treatment | | | | | | |
|---|---|---|---|---|---|---|---|
| | NC | RAC | RENZ1 | RENZ2 | RENZ1+2 | SEM | [1]P < |
| d 0 to 28 | | | | | | | |
| ADG[2], kg | 0.81 | 0.99 | 1.04 | 0.97 | 1.02 | 0.020 | 0.001 |
| ADFI, kg | 3.10 | 3.24 | 3.25 | 3.26 | 3.25 | 0.053 | 0.04 |
| G/F[2] | 0.26 | 0.31 | 0.32 | 0.30 | 0.32 | 0.007 | 0.001 |

[1]Main effect of Ractopamine (NC vs. RAC).
[2]RENZ1 improved ($P < 0.02$) ADG and G:F.

**Key Words:** glucanase, mannanase, ractopamine

## 097 The effects of feeding narasin on growth and harvest performance of pigs during the grow-finish period.

R. A. Arentson[1,*], J. J. Chewning[2], [1]Elanco, *Greenfield, IN,* [2]*Swine Research Services, Inc., Springdale, AR.*

The purpose of this study was to determine the effects of narasin (NAR; Skycis, Elanco Animal Health, Greenfield, IN) on the growth and harvest performance of pigs during the grow-finish period. On d –8 or –9, 74 pens each containing 8 pigs were blocked by gender and weight within each of 4 barns, resulting in 18 blocks containing 2 pens of gilts and 2 pens of barrows and 1 block containing 2 pens of gilts. On d 0 (initial BW 26.34 kg), diet treatments control (CON) or NAR 15 ppm were randomly assigned to pens within gender of each block. Pigs were fed a series of 5 corn–soybean meal diet phases with or without NAR premix. Pigs were weighed on d 0, 26, 54, 74, 95 or 96, and 109 or 110 to determine initial weight, phase weights, and ADG. Feed issuance and weigh backs were recorded in order to determine ADFI and G:F. On d 95 or 96, the heaviest 3 barrows and 1 gilt from appropriate pens and on d 109 or 110 the remaining pigs were transported to a food company for harvest. Fat depth, loin depth, and HCW were measured on each carcass. Data were analyzed using the PROC MIXED procedure of SAS. Pigs fed NAR had a greater BW on d 54 ($P < 0.01$), 74 ($P < 0.001$), and 95.5 ($P < 0.001$) and tended to be greater at the end of the study ($P < 0.1$) than pigs fed CON. Pigs fed NAR had a faster ADG during d 0 to 26 ($P < 0.05$), 26 to 54 ($P < 0.01$), and 54 to 74 ($P < 0.001$), and tended to be faster during d 0 to 109.5 ($P < 0.10$) than pigs fed CON. Feed intake by pigs fed NAR was greater during d 26 to 54 ($P < 0.05$) and d 54 to 74 ($P < 0.05$), but was less than CON from d 95.5 to 109.5 ($P < 0.05$). The G:F of pigs fed NAR was greater than CON on d 54 to 74 ($P < 0.01$) and d 0 to 109.5 ($P < 0.05$). On d 95.5 and 109.5, HCW ($P < 0.01$) and loin depth ($P < 0.01$) of pigs fed NAR was greater than pigs fed CON. Data from this study demonstrates that NAR improves growth