

SWINE DAY 2026

Kansas State University
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Evaluation of U.S. Grain Sorghum in Lactation Diets on Sow and Litter Performance

Grady A. Privett, Emily G. Skelton1, Jason C. Woodworth, Jordan T. Gebhardt[2], Katelyn N. Gaffield, Robert D. Goodband, Mike D. Tokach, Joel M. DeRouchey, Sierra M. Collier, Kyle F. Coble[1], Larissa L. Becker[1], Hilario M. Cordoba[1], and Morgan A. Schaeperkoetter[1]

Summary

A total of 568 sows (Line 1050, PIC) were used to evaluate the effects of U.S. grain sorghum compared with corn in lactation diets on sow and litter performance. Sows, in four separate farrowing groups (approximately 142 ± 1 sows per group), were moved into the farrowing house and blocked by parity on d 112 ± 1 of gestation. Sows were assigned to one of three dietary treatments, consisting of diets with 0, 50, or 100% of the corn replaced with sorghum. Diets were formulated to be balanced for amino acids, minerals, and energy. Corn and sorghum were given the same NE loading value (1,212 kcal/lb). Sows were fed 4 lb of their assigned treatment diet before farrowing, then were given ad libitum access until weaning (approximately d 19 of lactation). Replacing corn with sorghum in the diet did not affect sow weight, backfat, or caliper score change from entry to weaning. Feeding sows sorghum did not affect sow ADFI, litter feed conversion ratio, or wean-to-estrus interval. There were no differences in total born or total born alive. However, there was a decrease (quadratic, P = 0.003) in the percentage of stillborn pigs with increasing sorghum in the diet. Also, the percentage of mummies increased and then decreased (quadratic, P = 0.001) as sorghum inclusion increased. There were no differences after cross-fostering (d 1) or at weaning for litter size and litter weight. Preweaning mortality tended to decrease then increase (quadratic, P = 0.080) with increasing sorghum in the diet. Additionally, as sorghum increased, preweaning removals increased (linear, P = 0.046); however, no differences were observed in total removals and mortality. In conclusion, U.S. grain sorghum can replace corn in lactation diets with little impact on sow or litter performance.

[1] JBS Live Pork, Greeley, CO.
[2] Department of Diagnostic Medicine/Pathobiology, College of Veterinary Medicine, Kansas State University.

Effect of Increasing Feed Allocation or Added Soluble Fiber on the Performance and Behavior of Late Gestation Sows

Cooper T. McAuley, Carley R. Hopkins1, Jacob I. Knoy, Jason C. Woodworth, Robert D. Goodband, Jordan T. Gebhardt[2], Mike D. Tokach, Joel M. DeRouchey, Jay S. Johnson[1], Clayton S. Chastain[3], Eric Parr[3], Matt Frizzo[3], and Katelyn N. Gaffield

Summary

A total of 1,479 mixed-parity sows and gilts (1050, PIC) were used to evaluate the effects of increased feed allocation or added soluble fiber in diets fed the last two weeks of gestation on sow performance and behavior. Sows were housed in 28 pens containing 47 to 55 sows per pen. Each pen was equipped with three computerized gestation feeders. Pens of sows were blocked in groups to account for date of pen loading and then allotted to one of three treatments with nine or ten replications per treatment. Treatments consisted of: 1) control diet (corn-soybean meal-DDGS-based) fed at 5.5 lb/sow/day, 2) increased allocation of the control diet by 2.5 lb/sow/day (8.0 lb total feed/sow/day), and 3) 5.5 lb/sow/day of control diet plus 2.65 lb/d of added soybean hulls to provide over 100 g/d soluble fiber (8.15 lb total feed/sow/day). Pens contained sows with different breed dates and treatments started when the first sows reached d 104 of gestation. Sows were weighed the day before the start of treatment diets being offered and again when they entered farrowing. Sows were video recorded continuously, and video was analyzed on d 3 and 5 in six 2-h timeframes (0100 to 0300, 0500 to 0700, 0900 to 1100, 1300 to 1500, 1700 to 1900, and 2100 to 2300). Aggressive bouts were defined as: 1) sows knocking or pushing pen mates with their head; 2) sows mounting pen mates; or 3) sows forcefully biting ear, face, body, or vulva of pen mates. Sow body lesions and vulva lesions were also recorded the day before exposure to treatment and then again d 3 and 5 after exposure and finally upon entry to farrowing to measure the frequencies of scores. Four sows per pen were selected and had tear stain scores recorded the day before exposure to treatment and upon entry to farrowing to measure the frequencies of scores. One sow per pen was selected based on average body condition and parity of the pen for determination of salivary cortisol levels on d 3 and 5. Increasing feed allocation or added soluble fiber increased ($P < 0.05$) ADG compared with the control group. Increased feed allocation resulted in a greater ADFI compared with the added fiber treatment, and sows fed added dietary fiber had greater ADFI compared with control sows ($P < 0.05$). Regardless of treatment, vulva lesion and tear stain scores numerically became more prevalent at the end of the study as sows were entering farrowing. There were no differences in number of pigs born alive, stillborn, or weaned between treatments. There was a treatment × time interaction for total aggressive bouts ($P < 0.001$). Although the means did not separate at most timeframes, numerically, increased feed allocation and added fiber reduced total aggressive bouts at timeframes 0100 to 0300, 0500 to 0700, and 0900 to 1100, but had an inverse effect at timeframe 1700 to 1900. Sows fed added fiber diets had lower ($P < 0.05$) salivary cortisol levels compared with sows fed increased feed allocation, with control-fed sows intermediate. In conclusion, increasing feed allocation or added soluble fiber resulted in greater ADFI, as expected, which translated into an increase in ADG. Fewer total aggressive bouts were observed for the

[1] University of Missouri, Columbia, MO.
[2] Department of Diagnostic Medicine/Pathobiology, College of Veterinary Medicine, Kansas State University.
[3] Carthage Innovative Swine Solutions, Carthage, IL.

high feed allocation and added fiber treatments earlier in the day, but numerically increased total aggressive bouts at night. These data indicate that increased feed allocation or added fiber only in late gestation affected aggressive interactions, especially around the feed stations in the early morning. This reduction in aggression in the morning potentially led to differences between treatments in their physiological stress indicators taken at similar timepoints.

Effect of Supplementing Dietary Magnesium on the Performance and Behavior of Group-Housed Late Gestation Sows

Cooper T. McAuley, Carley R. Hopkins[1], Jason C. Woodworth, Robert D. Goodband, Jordan T. Gebhardt[2], Mike D. Tokach, Joel M. DeRouchey, Jay S. Johnson[1], Clayton S. Chastain[3], Eric Parr[3], Matt Frizzo[3], and Katelyn N. Gaffield

Summary

A total of 952 mixed-parity sows and gilts (1050, PIC) were used to evaluate the effects of supplementing 0.03% magnesium (Mg) through the inclusion of magnesium oxide (MgO) in the diet fed the last two weeks of gestation on sow performance and behavior. Sows were housed in 18 pens containing 49 to 56 sows per pen. Each pen was equipped with three computerized gestation feeders. Pens of sows were blocked in groups to account for date of pen loading and then allotted to one of two treatments with nine replications per treatment. Treatments consisted of: 1) control diet (corn-DDGS-based) fed at 5.0 lb/sow/day and 2) control diet supplemented with 0.03% Mg through the inclusion of 0.06% MgO. Pens contained sows with different breed dates and treatments started when the first sows reached d 104 of gestation (average day of gestation for the pens: 102.9 ± 1.27). Sows were weighed the day before the start of treatment administration and again upon entry into the farrowing house. Sow body lesions and vulva lesions were recorded the day before exposure to treatment and then again on d 3 and 5 after exposure and finally upon entry to the farrowing house to measure the frequencies of scores. Four sows per pen were selected and had tear stain scores recorded the day before exposure to treatment and upon entry to farrowing to measure the frequencies of scores. Sows were video recorded continuously, and video was analyzed on d 3 and 5 in six 2-h timeframes (0100 to 0300, 0500 to 0700, 0900 to 1100, 1300 to 1500, 1700 to 1900, and 2100 to 2300). Aggressive bouts were defined as: 1) sows knocking or pushing pen mates with their head; 2) sows mounting pen mates; or 3) sows forcefully biting ear, face, body, or vulva of pen mates. The location of aggressive bouts was recorded and categorized as either occurring at the feeder (feeder bout) or elsewhere in the pen (non-feeder bout). One sow per pen was selected based on average body condition and parity of the pen for determination of salivary cortisol levels on d 3 and 5. Those sows were followed through farrowing with one male and one female piglet of the average litter BW analyzed for plasma and hair cortisol concentrations. Piglets were restrained on their backs for 3 min before blood collection to induce a stress response, and immediately after, hair samples were taken from the rump and dorsal area. Sows fed increased Mg tended to have greater ADG and ADFI ($P \leq 0.076$) compared with sows fed the control diet. There were no differences in piglet total born, born alive, or number of stillborn; however, there was a tendency ($P = 0.063$) for sows fed increased Mg to have a greater number of pigs weaned. Sow fallout due to mortality or removal in late gestation and through farrowing was decreased ($P = 0.046$) with added Mg. Regardless of treatment, vulva lesion scores numerically became more prevalent at the end of the gestation as sows entered farrowing. The total aggressive bouts decreased ($P = 0.001$) as time of day progressed. Sows fed added Mg had more aggressive bouts at the feeder compared with those fed the control diet ($P = 0.001$). There were no differences in sow salivary, piglet plasma,

[1] University of Missouri, Columbia.
[2] Department of Diagnostic Medicine/Pathobiology, College of Veterinary Medicine, Kansas State University.
[3] Carthage Innovative Swine Solutions, Carthage, IL.

or hair cortisol levels. In conclusion, supplementing Mg at 0.03% from MgO tended to increase sow ADG and ADFI while decreasing late gestation and farrowing sow fallout. Increased feed intake and reduced fallout from sows fed added Mg may have potentially increased sow activity around feeding stations, contributing to more aggressive bouts at the feeder. Regardless of treatment, sow aggression reduced as the time of day progressed. Despite the effects on sow performance, increasing Mg by 0.03% displayed limited results as a mediator to sow behavior in a group-housed environment.

Supplementing Tryptophan in Late Gestation Diets to Group-housed Sows Under Commercial Conditions: Effects on Aggressive Interactions and Sow and Litter Performance

Cooper T. McAuley, Carley R. Hopkins1, Jason C. Woodworth, Robert D. Goodband, Jordan T. Gebhardt[2], Mike D. Tokach, Joel M. DeRouchey, Jay S. Johnson1, Clayton S. Chastain[3], Eric Parr[3], Matt Frizzo[3], and Katelyn N. Gaffield

Summary

A total of 948 mixed-parity sows and gilts were used to evaluate the effects of supplementing an additional 0.24% SID tryptophan in late gestation on sow performance and behavior. Sows were housed in 18 pens with pens randomly assigned based upon parity and breed date to either a control corn-soybean meal-DDGS-based diet containing 0.11% SID Trp (n = 9 pens/treatment with 52.3 ± 1.6 sows/pen) or the control diet supplemented with an additional 0.24% SID Trp, for a total of 0.35% (n = 9 pens/treatment with 53.6 ± 1.5 sows/pen). Each pen was equipped with three computerized gestation feeders. Pens contained sows with different breed dates and treatments started when the first sows reached d 105 of gestation. Sows were weighed the day prior to the start of treatment and again upon entering farrowing. Sows were video recorded continuously, and video was analyzed on d 3 and 5 in six 2-h timeframes (0100 to 0300, 0500 to 0700, 0900 to 1100, 1300 to 1500, 1700 to 1900, and 2100 to 2300). Aggressive bouts were defined as: 1) sows knocking or pushing pen mates with their head; 2) sows mounting pen mates; or 3) sows forcefully biting ear, face, body, or vulva of pen mates. Sow vulva lesions were also recorded the day before exposure to treatment and then again on d 3 and 5 after exposure and finally upon entry to farrowing. Four sows per pen were selected and had body lesions and tear stain scores recorded the day before exposure to treatment. Body lesions were later assessed on d 3 and 5 after exposure and upon entry into farrowing. Tear stain scores were also recorded upon entry to farrowing. One sow per pen was selected based on average body condition and parity of the pen for determination of salivary cortisol levels on d 3 and 5. Those sows were followed through farrowing with one male and one female piglet of the average litter BW being analyzed for plasma and hair cortisol concentrations. Piglets were restrained on their backs for 3 min before blood collection to induce a stress response; immediately after, hair samples were taken from the rump and dorsal area. There were no observed treatment differences in sow BW, ADG, ADFI, or litter characteristics. Treatment induced no effects on sow aggression or salivary cortisol, along with hair and plasma cortisol concentrations in subsequent piglets. Regardless of treatment, there was an observed increase ($P < 0.01$) in vulva lesions as sows approached farrowing. Sows supplemented with an additional 0.24% SID Trp had a lower ($P = 0.029$) tear stain score on average compared with sows fed the control. Overall, a 0.24% increase of SID Trp (0.11% vs. 0.35%) in late gestation diets had no effects on sow performance or aggressive behavior, and minimal influence on physiological stress indicators in a group-housed environment under commercial production conditions.

[1] University of Missouri, Columbia.
[2] Department of Diagnostic Medicine/Pathobiology, College of Veterinary Medicine, Kansas State University.
[3] Carthage Innovative Swine Solutions, Carthage, IL.

Effect of Increasing Standardized Ileal Digestible Arginine:Lysine Ratio in Lactation Diets Containing Elevated Histidine:Lysine Ratio on Sow and Litter Performance

Jacob I. Knoy, Jason C. Woodworth, Katelyn N. Gaffield, Mike D. Tokach, Joel M. DeRouchey, Robert D. Goodband, David A. Clizer[1], and Jordan T. Gebhardt[2]

Summary

A total of 124 mixed-parity sows (DNA 241) were used to determine the effect on sow and litter performance when increasing the SID Arg:Lys ratio in lactation diets containing an elevated SID His:Lys ratio. Sows were blocked by parity and balanced for body weight (BW) on approximately d 112 of gestation and allotted to one of three dietary treatments of increasing SID Arg:Lys ratios (90, 110, or 130% of Lys). Sows received approximately 6 lb/d of their treatment diet from d 112 of gestation until farrowing, after which they were provided ad libitum access to their treatment diet until weaning on approximately d 18 after farrowing. The same corn-soybean meal-DDGS-based diets were fed throughout the study and formulated to contain an SID His:Lys ratio of 43.5% by the addition of L-His. Litters were cross-fostered within 48 h of farrowing to equalize litter size within treatment. The SID Arg:Lys ratio did not affect sow BW change, backfat change, loin depth change, caliper score change, ADFI before farrowing or during lactation, or the weaning-to-estrus interval. Arginine intake increased (linear, $P < 0.001$) with increasing SID Arg:Lys ratio as expected. No differences were observed for the number of total pigs born or the percentage of total born alive, stillborn, and mummified, nor did treatment influence the litter size at any timepoint. At d 10, litter weight increased then decreased (quadratic, $P = 0.043$) with increasing SID Arg:Lys ratio, with a similar tendency (quadratic, $P = 0.097$) for weaning weight. From d 0 to weaning, litter weight gain increased (linear, $P = 0.047$) with increased SID Arg:Lys ratio. At d 0, litter weight coefficient of variation (CV) decreased (linear, $P = 0.013$) with increasing SID Arg:Lys ratio, with a similar tendency (linear, $P = 0.097$) for litter weight d 10 CV. At d 2, 10, and weaning, average piglet BW increased then decreased (quadratic, $P \leq 0.034$) with 110% Arg:Lys ratio having the heaviest average piglet BW. From d 2 to 10 and d 2 to weaning, litter ADG increased (linear, $P \leq 0.040$) with increasing SID Arg:Lys ratio. Additionally, from d 2 to 10 and d 2 to weaning, piglet ADG increased (linear, $P \leq 0.010$) with increasing SID Arg:Lys ratio and piglet ADG from d 10 to weaning marginally increased (linear, $P = 0.083$) with increasing SID Arg:Lys ratio. From d 2 to weaning and birth to weaning, preweaning mortality decreased (linear, $P \leq 0.032$) with increasing Arg:Lys ratio. From farrow to weaning, Arg intake/kg of litter gain (g/kg) increased (linear, $P < 0.001$) with increasing SID Arg:Lys ratio. In conclusion, the study provides evidence that feeding increased SID Arg:Lys ratio, in diets with an elevated His:Lys ratio, improved litter growth performance and reduced preweaning mortality.

[1] CJ America-Bio, Downers Grove, IL.
[2] Department of Diagnostic Medicine/Pathobiology, College of Veterinary Medicine, Kansas State University.

The Effect of Feeding VVC Premix in Lactation Diets on Sow and Litter Performance

Shannon A. Rossman[1], Jason C. Woodworth, Jordan T. Gebhardt[1], Sara Virdis[1], Katelyn N. Gaffield, Joel M. DeRouchey, Jon R. Bergstrom[2], and Sara Hough[2]

Summary

A total of 94 mixed-parity sows (DNA 241, DNA Genetics, Columbus, NE) were used to evaluate the effects of feeding a blend of benzoic acid and essential oils (VVC Premix, dsm-firmenich, Animal Nutrition & Health, LLC, Pendergrass, GA) in lactation diets on sow and litter performance. Sows, in three farrowing groups, were moved into the farrowing house on d 110 of gestation and blocked by parity then randomly assigned to one of two dietary treatments consisting of a control diet or the control diet with VVC Premix included at 7 lb/ton. There were 47 sows per treatment. Sows were fed treatment diets from d 110 of gestation until weaning with sows receiving up to 6 lb/d of their respective treatment diets before farrowing and then were given ad libitum access to their assigned treatment diet until weaning. Sow BW, backfat, loin depth, and caliper score changes were unaffected by VVC Premix. Sows fed the control diet had increased (P = 0.002) ADFI from entry until farrowing. However, during the lactation period, sows fed diets with VVC Premix had a marginally increased (P = 0.065) ADFI compared with the control. Total born, total born alive, stillborn, and mummified pigs did not differ between treatment diets. Litter size, piglet BW, litter ADG, and piglet ADG on d 0, 2, 10, and at weaning were not influenced by treatment diet. Preweaning mortality from d 2 to weaning was reduced (P = 0.009) when sows were fed VVC Premix. In conclusion, these data suggest minimal differences in sow and litter performance with VVC Premix inclusion in lactation diets, although increased lactation feed intake and reduced preweaning mortality were observed.

[1] Department of Diagnostic Medicine/Pathobiology, College of Veterinary Medicine, Kansas State University.
[2] dsm-firmenich, Animal Nutrition & Health, LLC, Pendergrass, GA.

Effect of Sire Line and Creep Feed on Sow and Litter Performance Following a Natural Porcine Reproductive and Respiratory Syndrome Virus Infection

Jacob I. Knoy, Joel M. DeRouchey, Katelyn N. Gaffield, Jason C. Woodworth, Christopher L. Puls1, Katherine A. McCormick[1], Chris L. Eden[1], Eric Nyberg[1], Alan Bainbridge[1], Matthew J. Ritter[1], and Jordan T. Gebhardt[2]

Summary

A total of 177 gilts and sows (PIC 1050) were used to determine the effects of sire line and creep feed on sow and litter performance during a natural porcine reproductive and respiratory syndrome virus (PRRSV) challenge. Sows were blocked by previous lactation treatment, BW, and parity at breeding and allotted to one of three sire line treatments. Gilts were blocked by breed weight and assigned to one of three sire line treatments. Sire line treatments were Pietrain- or Duroc-based, with sire line A being from a Pietrain sire line and sire lines B and C being from Duroc sires. A common diet was provided during gestation with feed allowance adjusted based on body condition. On d 108 of gestation, sows and gilts were moved into the farrowing facility and provided a common corn-soybean meal-based lactation diet. Litters were cross-fostered within 24 h of farrowing to equalize litter size within sire line treatment. Seven days before weaning, litters were assigned to one of two creep feeding treatments (with or without creep feed) in a randomized complete block design based on sire line treatment. Litters assigned to creep feed received a phase 1 nursery diet until weaning. No significant sire line × creep feed interactions were observed for sow and litter performance throughout the trial. There were minimal effects of creep feeding observed throughout the duration of the study. A difference in sow BW at entry and farrowing was observed ($P < 0.05$), with sows bred to sire line B having increased BW compared with sows bred to other treatments. At weaning, sows bred to sire line B had increased ($P < 0.05$) BW compared with those bred to sire line A, with sows bred to sire line C being intermediate. Sows bred to sire line A tended ($P = 0.097$) to have the greatest BW loss from entry to wean with no mean separation; however, no difference was observed from farrow to wean. A tendency for a difference in ADFI before farrowing was observed ($P = 0.086$), with sows bred to sire line B exhibiting increased feed intake compared with sows bred to other sire line treatments, but there was no mean separation. For lactation length, a significant effect of sire line was observed ($P < 0.05$), with sows bred to sire line B having the shortest lactation length compared with the other sire line treatments. No differences were observed in sow ADFI, wean-to-estrus interval, number exhibiting estrus by 9 d after weaning, and pregnancy check at d 35 after weaning. No differences were observed for the percentage of total born alive, stillborn, and mummified, litter size, litter weight, percentage of weaned pigs under 8 lb per litter, litter coefficient of variation, litter ADG, or preweaning mortality. At birth, d 12, and weaning, average piglet BW decreased ($P < 0.05$) in offspring from sire line B compared with other treatments; however, no difference was observed at d 1 after standardization. No difference was observed in piglet ADG from d 12 to wean and d 1 to wean; however, from d 1 to 12, piglet ADG was greater ($P < 0.05$) in litters from sire line C compared with sire line B, with sire line A being intermediate. In conclusion, no interactive effects were observed between sire line and creep feed treatment, and minimal main effects were observed for creep feed throughout the study. Offspring from sire line B had reduced birth and weaning weights compared with other sire line treatments.

[1] United Animal Health, Sheridan, IN.

[2] Department of Diagnostic Medicine/Pathobiology, College of Veterinary Medicine, Kansas State University.

Utilization of Enrichment Blocks in Group-Housed Sows Under Commercial Conditions: Effects on Aggressive Interactions and Sow and Litter Performance

Cooper T. McAuley, Carley R. Hopkins[1], Jason C. Woodworth, Robert D. Goodband, Jordan T. Gebhardt[2], Mike D. Tokach, Joel M. DeRouchey, Jay S. Johnson[1], Clayton S. Chastain[3], Eric Parr[3], Matt Frizzo[3], and Katelyn N. Gaffield

Summary

A total of 960 mixed-parity sows and gilts (1050, PIC) were used to evaluate the effects of environmental enrichment during the last two weeks of gestation on sow performance and behavior. Gestating sows were randomly assigned to control pens with no enrichment (n = 9 pens; 53.2 ± 2.2 sows/pen) or pens containing three molasses and beet pulp-based enrichment blocks (n = 9 pens; 53.4 ± 1.1 sows/pen). Sows were weighed the day prior to the start of treatment and again upon entry into farrowing. Sow body lesions and vulva lesions were recorded the day before exposure to treatment and then again on d 3 and 5 after exposure and finally upon entry to farrowing. Four sows per pen were selected and had tear stain scores recorded the day before exposure to treatment and upon entry to farrowing. Sows were video recorded continuously, and video was analyzed on d 3 and 5 in six 2-h time frames (0100 to 0300, 0500 to 0700, 0900 to 1100, 1300 to 1500, 1700 to 1900, and 2100 to 2300). Aggressive bouts were defined as 1) sows knocking or pushing pen mates with their head; 2) sows mounting pen mates; or 3) sows forcefully biting ear, face, body, or vulva of pen mates. The location of aggressive bouts was recorded and categorized as either occurring at the feeder (feeder bout) or elsewhere in the pen (non-feeder bout). One sow per pen was selected based on average body condition and parity of the pen for determination of salivary cortisol levels on d 3 and 5. Those sows were followed through farrowing with one male and one female piglet of the average litter BW being analyzed for plasma and hair cortisol concentrations. Piglets were restrained on their backs for 3 min prior to blood collection to induce a stress response, and hair samples were taken from the rump and dorsal area immediately after. Sows assigned to the enrichment blocks tended to have increased (P = 0.051) ADFI; however, this did not translate to a difference in ADG during late gestation. No differences were observed in total born, live born, stillborn or number weaned. The use of enrichment blocks led to a reduction (P = 0.029) in total aggressive bouts within pens, driven by the tendencies for reduction (P ≤ 0.096) in both feeder and non-feeder aggressive bouts. Regardless of treatment, total aggressive interactions were greater (P < 0.01) on d 3 than on d 5 and declined (P < 0.01) as time of day progressed. No differences in sow salivary cortisol concentrations, piglet hair cortisol concentrations, or piglet plasma cortisol concentrations were observed. In conclusion, the provision of environmental enrichment during late gestation modestly reduced aggressive interactions but did not affect sow and litter performance or physiological stress indicators in a group-housed environment under commercial production conditions.

[1] University of Missouri, Columbia, MO.
[2] Department of Diagnostic Medicine/Pathobiology, College of Veterinary Medicine, Kansas State University.
[3] Carthage Innovative Swine Solutions, Carthage, IL.

Longitudinal Characterization of Sow and Growing Pig Blood Criteria

Grady A. Privett, Ursula M. McCormack1, Jon R. Bergstrom[1], Lisa A. Laprade[1], Jason C. Woodworth, Jordan T. Gebhardt[2], Katelyn N. Gaffield, Robert D. Goodband, Mike D. Tokach, and Joel M. DeRouchey

Summary

A total of 10 high-health sows and 141 high-health offspring (DNA 600 × 241) from the sows' first litter were used to characterize circulating blood criteria concentrations over three parities of the sow and in the piglets from weaning until market. Non-fasted blood samples were collected from the same sows at entry into the farrowing house, 3 d before their first farrowing cycle, and then at weaning for their first, second, and third litters. Additionally, non-fasted blood samples were collected from each pig at weaning (d 18 of life), end of the nursery period (d 70 of life), midpoint of the finisher (d 123 of life), and end of the finisher (d 161 of life). Whole blood samples were analyzed for a panel of 24 blood criteria, including proteins, vitamins, and minerals, using iCheck (BioAnalyt, Teltow, Germany), iSTAT Alinity (Abbott, Abbott Park, IL), and VetScan (Zoetis, Parsippany, NJ)-based rapid analysis technologies. Sows and offspring were fed corn-soybean meal-based diets formulated to meet or exceed the nutrient requirement estimates established by NRC (2012) and diets were typical of those fed in commercial production. All pigs were healthy throughout the course of blood collection. These data provide a broad characterization of whole blood criteria concentrations for the first three parities of sows and from weaning through harvest of the offspring from the sow's first litter.

[1] dsm-firmenich, Parsippany, NJ.
[2] Department of Diagnostic Medicine/Pathobiology, College of Veterinary Medicine, Kansas State University.

Effects of a Silicic Acid and Fructo-oligosaccharide Feed Additive With or Without Pharmacological Levels of Zinc on Growth Performance, Fecal Dry Matter, and Blood Biomarkers of Weanling Pigs Experimentally Infected with Enterotoxigenic *Escherichia coli*

Jacob I. Knoy, Jordan T. Gebhardt[1], Sara Virdis[1], Katelyn N. Gaffield, Jason C. Woodworth, Joel M. DeRouchey, Raghavendra G. Amachawadi[2], Harith Salih[2], Taghreed Mahmood[2], Franco Matias Ferreyra[3], and Taw Scaff[4]

Summary

A total of 88 weanling pigs (241 × 600 DNA; initially 14.0 lb) were used in a 28-d study using two groups of pigs (44 pigs/group) to evaluate the effects of a silicic acid (SA) and short-chain fructo-oligosaccharide (FOS) feed additive with or without pharmacological levels of zinc (Zn) from zinc oxide on growth performance and fecal dry matter (DM) in enterotoxigenic Escherichia coli F18 (ETEC) challenged nursery pigs. Within group, pigs were weaned and randomly allotted to one of four dietary treatments in a completely randomized design. There were 22 pigs per dietary treatment, and diets were fed in two phases with phase 1 being fed from d 0 to 10 after weaning, and phase 2 being fed from d 10 after weaning until the conclusion of the trial on d 28 after weaning. The four dietary treatments were arranged in a 2 × 2 factorial with main effects of SA/FOS feed additive (none or 0.5 lb/ton of complete feed; Improx, Addix Biotech, Weston, FL) and pharmacological levels of Zn from ZnO (no supplemental Zn from ZnO or 2,990 mg/kg added in phase 1 and 2,018 mg/kg in phase 2). All diets contained 110 mg/kg Zn from the base trace mineral premix. Pigs were group-housed for a 14-d acclimation period after weaning, then moved to individual pens and inoculated with 6 mL of solution containing approximately 107 CFU/mL of ETEC F18 administered via orogastric gavage with a rubber catheter. During period 1 after inoculation (d 14 to 17 after weaning), an SA/FOS × pharmacological Zn interaction was observed for ADG ($P = 0.027$), resulting from no difference when pigs were fed pharmacological levels of Zn with or without SA/FOS; however, without pharmacological levels of Zn, supplementing SA/FOS improved ($P < 0.05$) ADG. Overall, pharmacological levels of Zn improved d 28 BW, ADG, and ADFI ($P < 0.001$). A SA/FOS × day interaction was observed ($P = 0.050$) for fecal DM, with a significant decrease in fecal DM on d 21 ($P = 0.023$) in pigs fed SA/FOS, but no significant differences on other days. There was a significant Zn × day interactive effect ($P = 0.034$) for fecal DM with an increase in fecal DM on d 17, 21, and 28 ($P \leq 0.009$) in pigs fed pharmacological levels of Zn but no significant differences on d 10 or 14. For the cytokine analysis, a significant SA/FOS × pharmacological Zn × day interaction was observed ($P = 0.032$; Table 4) for IL-1β, where an SA/FOS × pharmacological Zn interaction was observed on d 21 ($P = 0.030$), resulting from a reduction when pigs were fed pharmacological levels of Zn without SA/FOS; however, with SA/FOS, pharmacological levels of Zn increased IL-1β, with no significant differences observed on other days. In conclusion, an interactive effect was observed in period 1 on ADG, resulting from no difference in ADG

[1] Department of Diagnostic Medicine/Pathobiology, College of Veterinary Medicine, Kansas State University.
[2] Department of Clinical Sciences, College of Veterinary Medicine, Kansas State University.
[3] Veterinary Diagnostic Laboratory, College of Veterinary Medicine, Kansas State University.
[4] Addix Biotech, Weston, FL.

when pigs were fed pharmacological levels of Zn with or without SA/FOS; however, without pharmacological levels of Zn, supplementing SA/FOS improved ADG. The combination of SA/FOS and Zn marginally increased pro-inflammatory and anti-inflammatory cytokines during the study. Treatment differences were observed in survival probability by day after pigs were inoculated with enterotoxigenic Escherichia coli, with survival probability lower for pigs fed the control diet compared with other treatments. Overall, pigs fed pharmacological levels of Zn had improved ADG, ADFI, and fecal DM throughout the study.

Effects of a Silicic Acid and Fructo-oligosaccharide Feed Additive in Nursery Pig Diets With or Without Pharmacological Levels of Zinc

Jacob I. Knoy, Sara Virdis[1], Jordan T. Gebhardt[1], Katelyn N. Gaffield, Jason C. Woodworth, Joel M. DeRouchey, Taw Scaff[2], and Joana Magoga[1]

Summary

A total of 360 nursery pigs (DNA 600 × 241; initially 12.8 ± 0.03 lb) were used in a 42-d study to determine the effects on growth performance and fecal dry matter (DM) of a silicic acid (SA) and short-chain fructo-oligosaccharide (FOS) feed additive included in nursery pig diets with or without pharmacological levels of zinc (Zn) from zinc oxide. At approximately 19 d of age, pigs were weaned, blocked by initial BW, and allotted to one of four dietary treatments in a generalized randomized block design with 18 replicates per treatment. Diets were formulated in three phases and fed from d 0 to 10, 10 to 24, and 24 to 42. The four dietary treatments were arranged in a 2 × 2 factorial with main effects of SA/FOS feed additive (none or 0.5 lb/ton of complete feed; Improx, Addix Biotech, Weston, FL) and pharmacological levels of Zn from ZnO (none or 2,990 mg/kg added in phase 1 and 2,018 mg/kg in phase 2). All diets contained 110 mg/kg Zn from the base trace mineral premix. Pens of pigs were weighed on d 0, 10, 17, 24, 35, and 42 to determine growth performance, and on d 10 and d 24 of the study, fecal samples were collected from three pigs per pen to determine fecal DM. There were no interactions between SA/FOS and pharmacological levels of Zn throughout the study. Overall (d 0 to 42), pharmacological levels of Zn improved d 42 BW, ADG, ADFI, and F/G ($P \leq 0.007$). Fecal DM at both d 10 and 24 was higher ($P \leq 0.015$) in pigs fed pharmacological levels of Zn. There were no main effects observed for SA/FOS throughout the trial. In conclusion, there were no interactive effects between SA/FOS and pharmacological levels of Zn, as well as no main effects observed for SA/FOS throughout the study. Pigs fed pharmacological levels of Zn had improved ADG, ADFI, F/G, and fecal DM throughout the nursery period.

[1] Department of Diagnostic Medicine/Pathobiology, College of Veterinary Medicine, Kansas State University.
[2] Addix Biotech, Weston, FL.

Determining the Effects of Sodium Bisulfate in Low Acid Binding Capacity-4 (ABC-4) Diets on Nursery Pig Performance and Fecal Dry Matter

Cooper McAuley, Katelyn N. Gaffield, Jordan T. Gebhardt[1], Jason C. Woodworth, Joel M. DeRouchey, and Craig Coufal[2]

Summary

A total of 360 pigs (DNA 241 × 600, initial BW 12.3 ± 0.03 lb) were used in a 42-d growth study to determine the effects of sodium bisulfate compared with formic acid in low acid binding capacity-4 (ABC-4) diets on nursery pig growth performance and fecal dry matter (DM). At weaning, pigs were randomly allotted within three body weight blocks to one of six dietary treatments in a generalized randomized block design. There were 12 replicate pens per treatment and five pigs per pen. The experimental diets were fed in three dietary phases and were corn-soybean meal-based formulated using a low ABC-4 strategy including crystalline lactose, microbial enhanced soybean meal, and fumaric acid in the first two phases. Dietary treatments consisted of five increasing levels of sodium bisulfate (0, 0.40, 0.50, 0.60, and 0.70%) and a treatment with 0.70% formic acid to directly compare to the 0.70% sodium bisulfate treatment. Fecal samples were collected on d 10 and 24 of the experiment from the same three pigs per pen for analysis of fecal DM. From d 0 to 10 and d 10 to 24 (phases 1 and 2), there were no differences in growth performance between dietary treatments. From d 24 to 42 (phase 3), ADFI and F/G decreased and then increased (quadratic, P ≤ 0.013) as sodium bisulfate increased in the diet with pigs fed 0.40% sodium bisulfate having the lowest ADFI and F/G. A similar tendency was observed for ADG and d 42 BW (quadratic, P ≤ 0.070). Additionally, in phase 3, formic acid inclusion improved (P = 0.009) F/G compared with pigs fed 0.70% sodium bisulfate. Overall (d 0 to 42), sodium bisulfate decreased and then increased (quadratic, P ≤ 0.048) ADFI and F/G as its inclusion level increased, with a similar tendency (quadratic, P = 0.060) observed for ADG. Also, the diet containing formic acid improved (P = 0.005) F/G compared with pigs fed 0.70% sodium bisulfate. For fecal DM, there were no observed differences on d 10, but on d 24, fecal DM decreased and then increased (quadratic, P = 0.013) with increasing sodium bisulfate inclusion with pigs fed 0.40% sodium bisulfate having the lowest fecal DM. In conclusion, neither sodium bisulfate nor formic acid influenced growth performance or fecal DM during the early nursery period in a low ABC-4 diet formulation strategy. During the late nursery period, when ingredients such as fumaric acid associated with a low ABC-4 formulation strategy were removed from the diet along with zinc oxide, sodium bisulfate had a quadratic effect on growth performance and fecal DM with lower inclusion levels reducing performance but then performance increased with higher levels reverting back to similar levels as the control. Furthermore, formic acid at similar inclusion levels to sodium bisulfate improved F/G, translating into overall improvements in feed efficiency during the nursery period.

[1] Department of Diagnostic Medicine/Pathobiology, College of Veterinary Medicine, Kansas State University.
[2] Jones-Hamilton Co., Maumee, OH.

The Effect of Feeding VVC Premix in Nursery Diets for Pigs from Sows Fed With and Without VVC Premix in Lactation on Nursery Growth Performance and Fecal Dry Matter

Shannon A. Rossman[1], Jason C. Woodworth, Jordan T. Gebhardt[1], Sara Virdis[1], Katelyn N. Gaffield, Joel M. DeRouchey, Jon R. Bergstrom[2], and Sara Hough[2]

Summary

A total of 360 mixed-sex weanling pigs (DNA 241 × 600; initial BW of 12.6 ± 0.04 lb) were used in a 45-d growth trial to evaluate the effects of previous sow lactation feed treatment (control vs. VVC Premix; dsm-firmenich, Animal Nutrition & Health, LLC, Pendergrass, GA) and nursery diets formulated with or without VVC Premix on growth performance and fecal dry matter. Pigs were weaned at approximately 18 d of age from sows fed lactation diets with or without VVC Premix at an inclusion of 7 lb/ton and allotted to pens of five pigs according to their dam's lactation treatment. Pens were assigned to one of two nursery treatments in a generalized randomized block design with BW as a blocking factor with 18 replications per treatment. Nursery diets followed a 3-phase schedule and consisted of either a control diet or the control diet with VVC Premix included at 7 lb/ton at the expense of corn. Pigs used for this trial were from one of three groups of sows as part of the lactation portion of the trial and although there was no overall impact of sow treatment on weaning weight, offspring from sows fed the control diet in lactation from this group of sows were heavier ($P < 0.001$) at weaning compared with those from the sows fed diets with VVC Premix, and this weight advantage was maintained throughout the study ($P \leq 0.031$). Sow × nursery interactions were observed for d 10 BW and d 0 to 10 ADG and F/G, where pigs from sows fed the control diet in lactation that were also fed the control diet in the nursery were heavier ($P < 0.05$) on d 10 and had an improved ($P \leq 0.05$) ADG and F/G compared with pigs from sows fed VVC Premix and subsequently fed the control diet in the nursery, with the other treatment combinations showing an intermediate response. From d 10 to 24 and d 24 to 45, no sow × nursery interactions were observed. However, main effects of nursery diet were observed for d 10 to 24 growth performance, where pigs fed VVC Premix in the nursery had a reduced ($P = 0.011$) ADG driven by reduced ($P < 0.001$) ADFI, but had an improved ($P = 0.009$) F/G. From d 24 to 45, pigs from sows fed the control diet had an improved ($P = 0.036$) F/G compared with pigs from sows fed VVC, whereas pigs fed VVC in the nursery had improved ($P = 0.008$) F/G compared with pigs fed the control diet. A tendency for a main effect of sow diet on d 24 to 45 ADG was also observed where pigs from sows fed the control diet tended to have improved ($P = 0.085$) ADG. No sow × nursery interactions were observed in the overall period; however, pigs from sows fed the control diet had increased ($P = 0.026$) ADG and improved ($P = 0.002$) F/G, while feeding VVC Premix in nursery diets reduced ($P = 0.036$) ADFI and improved ($P < 0.001$) F/G. For fecal DM, no significant interactions or main effect treatment differences were observed. In conclusion, including VVC Premix in nursery diets improved feed efficiency of weanling pigs. For this group of pigs, offspring from sows fed VVC Premix in lactation had reduced nursery performance and were lighter at weaning, which was not evident during the overall sow lactation trial that included two other groups of weaned pigs.

[1] Department of Diagnostic Medicine/Pathobiology, College of Veterinary Medicine, Kansas State University.
[2] dsm-firmenich, Animal Nutrition & Health, LLC, Pendergrass, GA.

Evaluation of SID Lys:CP Ratios for 14 to 25 lb Pigs Through the Use of Diammonium Phosphate as a Non-Protein Nitrogen Source

Jessica L. Smallfield, Katelyn N. Gaffield, Jason C. Woodworth, Joel M. DeRouchey, and Jordan T. Gebhardt[1]

Summary

A total of 360 barrows (DNA 200 × 400; initially 13.7 ± 0.09 lb) were used in a 32-d study to evaluate the effect of standardized ileal digestible lysine to crude protein (SID Lys:CP) ratios for 14 to 25 lb pigs in diets containing diammonium phosphate (DAP) as a non-protein nitrogen source. Pens of pigs were randomly allotted to one of six dietary treatments in a generalized randomized block design with BW as a blocking factor. There were four replications for each treatment within each BW block of light pigs (initially 12.3 ± 0.09 lb), medium pigs (initially 13.6 ± 0.09 lb), and heavy pigs (initially 15.2 ± 0.09 lb). There were five pigs per pen and 12 pens per treatment. Diets were corn-soybean meal-based with titrated amounts of diammonium phosphate (1.93, 1.51, 1.10, 0.72, 0.35, and 0%) resulting in SID Lys:CP ratios of 6.41, 6.57, 6.73, 6.89, 7.05, and 7.21%, respectively. Treatment diets were fed in one phase from d 0 to 18 (14 to 25 lb) followed by a common diet from d 18 to 32. On d 18, fecal samples were collected from three randomly selected pigs in each pen to determine fecal DM, and a blood sample was collected after a 12-h fasting period from one randomly selected pig in each pen to measure serum urea nitrogen. From d 0 to 18, decreasing the SID Lys:CP ratio through increased DAP decreased ADG, ADFI, and d 18 BW (linear, $P \leq 0.029$). Feed efficiency (F/G) tended to improve (linear, $P = 0.082$) as the SID Lys:CP ratio decreased. During the common period from d 18 to 32, no treatment differences were observed for ADG, ADFI, or F/G. However, decreasing SID Lys:CP ratio with increased addition of DAP tended to decrease d 32 BW (linear, $P = 0.053$). Overall, from d 0 to 32, decreasing SID Lys:CP ratio with increased DAP tended to decrease ADG (linear, $P = 0.056$) and decreased ADFI (linear, $P = 0.039$) but did not affect F/G. Decreasing SID Lys:CP ratio with DAP addition increased serum BUN (linear, $P < 0.001$) and decreased fecal DM (linear, $P = 0.028$). In conclusion, decreasing the SID Lys:CP ratio by increasing DAP as a non-protein nitrogen source decreased ADG and ADFI during the experimental period, which may have been caused by reduced diet palatability from the DAP addition. Additionally, fecal DM decreased as the SID Lys:CP ratio decreased, potentially due to the associated increase in dietary CP. Similarly, serum BUN increased with decreasing SID Lys:CP ratio, likely reflecting the higher CP concentration of the diets.

1 Department of Diagnostic Medicine/Pathobiology, College of Veterinary Medicine, Kansas State University.

An Industry Survey of the Composition and Variability of Soybean Meal Across US Soybean Processing Plants

Sierra M. Collier, Katelyn N. Gaffield, Robert D. Goodband, Mike D. Tokach, Joel M. DeRouchey, Jason C. Woodworth, Hari B. Krishnan[1], and Jordan T. Gebhardt[2]

Summary

Soybean meal is the primary protein source used in swine diets; however, updated, large-scale surveys describing its current composition and variability across US soybean processing plants are limited. This survey captured approximately half of the US soy processing plants (29 unique plants including two extruded-expelled plants), ensuring a representative range in crush capacity and geographical location. Samples were collected at two timepoints within the same crop year (from October 2024 to January 2025 and from June to August 2025). At each timepoint, five samples were collected over the course of one month to provide a thorough representation of the soybean meal composition at that facility. Therefore, 271 soybean meal samples in total were received for analysis. Samples were analyzed in duplicate for proximate analysis, neutral detergent fiber, oligosaccharides, fatty acid profile, amino acid profile, protein dispersibility index (PDI), protein solubility in potassium hydroxide (KOH), trypsin inhibitor units, urease activity, mineral analysis, bulk density, and flowability at the University of Missouri (Columbia, MO) or the Kansas State University Swine Laboratory (Manhattan, KS), depending on the assay. Overall, soybean meal composition was noticeably consistent between seasonal sampling periods; however, processing method largely affected the composition of the soybean meal. As expected, solvent-extracted soybean meal had higher crude protein (47 vs. 42%), lower ether extract (1.9 vs. 9.5%), and lower trypsin inhibitor units (4.6 vs. 14.7 TIU/mg) compared with extruded-expelled soybean meal. Furthermore, measurable variation was observed, both between and within processing plants, particularly in ether extract, calcium, trypsin inhibitor units, KOH, PDI, and particle size. For solvent extraction plants, ether extract ranged from 0.73 to 5.22%, calcium ranged from 0.18 to 0.82%, trypsin inhibitor units ranged from 0.61 to 9.58 TIU/mg, KOH ranged from 74.82 to 93.65%, PDI ranged from 8.60 to 48.37%, and particle size ranged from 546 to 1,508 μm. Other analyses, notably crude protein, amino acids, and fatty acids showed less variability, both between and within processing plants. For samples collected from solvent extraction plants, the average crude protein was 46.9 ± 0.97% with lysine averaging 3.07 ± 0.12%. These findings provide an updated industry benchmark describing the current composition and variability of US soybean meal to support precision diet formulation, quality assessment, and informed collaboration between soybean processors and animal nutritionists.

[1] Agricultural Research Service, U.S. Department of Agriculture and Division of Plant Science and Technology, University of Missouri, Columbia, MO.
[2] Department of Diagnostic Medicine/Pathobiology, College of Veterinary Medicine, Kansas State University.

Analytical Variation Between and Within Laboratories When Measuring Soybean Meal Composition and Quality

Sierra M. Collier, Katelyn N. Gaffield, Robert D. Goodband, Mike D. Tokach, Joel M. DeRouchey, Jason C. Woodworth, Hari B. Krishnan1, and Jordan T. Gebhardt [2]

Summary

Accurate laboratory analysis is critical for evaluating soybean meal composition and quality; however, differences in analytical procedures and laboratory practices can contribute to variability in reported nutrient values, creating challenges in diet formulation. Therefore, the objective of this study was to quantify between and within laboratory variation for common soybean meal quality analytical assays. One sample was collected from 27 US soybean processing plants and analyzed in quadruplicate for proximate analysis, neutral detergent fiber, calcium, phosphorus, trypsin inhibitor, and amino acid profile. Samples were analyzed at four laboratories: University of Missouri (Columbia, MO), Eurofins Food Chemistry Testing Center (Des Moines, IA), ATC Scientific (Little Rock, AR), and Midwest Laboratories (Omaha, NE), except for trypsin inhibitor, which was analyzed at USDA-ARS (Columbia, MO), Eurofins Food Chemistry Testing Center, and ATC Scientific. Data are presented through descriptive statistics as mean ± standard deviation, with corresponding minimum and maximum values to describe the range for each analysis within laboratory. To further evaluate analytical variation, the coefficient of variation (CV) was calculated for each analyte. Within laboratory CV was calculated using the mean and standard deviation of the four independent subsamples analyzed within each laboratory, representing analytical repeatability. Between laboratory CV was calculated using the mean values from each laboratory for a given analyte, with the standard deviation representing variation between laboratories, reflecting analytical reproducibility. Between laboratory variation was lowest for dry matter and crude protein, with CV values ranging from 0.33 to 0.76% and 0.05 to 1.49%, respectively, suggesting there was little variation between labs for these analytes. Moderate variation between laboratories was observed with CV values ranging from 1.84 to 12.92% for crude fiber, 2.55 to 9.64% for ash, 0.93 to 15.45% for calcium, and 1.22 to 6.87% for phosphorus, whereas ether extract and NDF exhibited the greatest variation between laboratories with CV values ranging from 1.52 to 32.67% and 2.03 to 23.07%, respectively. Amino acid variability between laboratories was analyte-dependent, ranging from 0.25 to 31.25%, with greater variation observed for tryptophan and cysteine. Within laboratory variation indicated strong repeatability for most analyses, with dry matter and crude protein consistently below 3.54% CV and the majority of samples across assays had a CV below 10%. In contrast, trypsin inhibitor exhibited the greatest variability within laboratories with CV values ranging from 0.11 to 62.09%, and direct comparison between laboratories was not appropriate due to methodological differences. Quantifying analytical variation between and within laboratories provides insight into the repeatability and reproducibility of commonly used soybean meal assays and will help guide best practices when evaluating soybean meal for diet formulation.

[1] Agricultural Research Service, U.S. Department of Agriculture and Division of Plant Science and Technology, University of Missouri, Columbia, MO.

[2] Department of Diagnostic Medicine/Pathobiology, College of Veterinary Medicine, Kansas State University.

Effects of Sire Line, Creep Feeding, and Plane of Nursery Nutrition on Growth Performance, Fecal Score, Antibiotic Injection Rate, and Removals and Mortalities of Nursery Pigs

Jacob I. Knoy, Joel M. DeRouchey, Katelyn N. Gaffield, Jason C. Woodworth, Christopher L. Puls1, Michelle McCallum[1], Eric Nyberg[1], Gerielle Suffy[1], Matthew J. Ritter[1], and Jordan T. Gebhardt[2]

Summary

A total of 1,692 pigs (sire line × PIC 1050) were used in a 42-d trial to determine the effects of sire line, creep feeding, and plane of nursery nutrition on growth performance, fecal score, antibiotic injection rate, and removals and mortalities of nursery pigs weaned from sows that had a natural porcine respiratory and reproductive syndrome virus (PRRSV) challenge during gestation. At approximately 19 d of age, pigs were weaned, blocked by sire line and creep feed treatment and sex, then balanced for weight, and allotted to one of two dietary treatments in a randomized complete block design with 10 pigs per pen and 14 replicates per treatment. Treatments were arranged in a 3 × 2 × 2 factorial with main effects of sire line, lactation creep feeding (with or without), and plane of nutrition. Sire line treatments were Pietrain- or Duroc-based, with sire line A being from a Pietrain sire line and sire lines B and C being from Duroc sires. Treatment diets were corn-soybean meal-based formulated to either a low or high plane of nutrition with different SID Lys concentrations (1.30% vs. 1.50%) and different inclusion levels of specialty ingredients, including whey powder, enzymatically treated soybean meal, blood plasma, and fish meal. No significant sire line × creep feed × plane of nutrition, sire line × creep feed, or creep feed × plane of nutrition interactions were observed for nursery performance throughout the trial. In phase 1 (d 0 to 10), pigs provided creep feed had decreased ($P \leq 0.016$) ADG and ADFI and poorer F/G compared with pigs not provided creep feed. Pigs fed the high plane of nutrition had improved ($P \leq 0.006$) ADG, d 10 BW, and F/G compared with pigs fed the low plane of nutrition. In phase 2 (d 10 to 21), offspring from sire line A had improved ($P < 0.05$) ADG and F/G compared with offspring from sire line C, with offspring from sire line B being intermediate. Pigs fed a high plane of nutrition had increased ($P = 0.048$) ADG compared with pigs fed a low plane of nutrition. In phase 3 (d 21 to 42), pigs from sire line B had improved ($P < 0.05$) F/G compared with pigs from sire line C, with pigs from sire line A being intermediate. Overall (d 0 to 42), pigs from sire lines A and B had improved ($P < 0.05$) F/G compared with pigs from sire line C. Pigs fed a high plane of nutrition improved ($P \leq 0.021$) ADG and F/G compared to pigs fed the low nutrition plane throughout the trial. During phase 3 (d 21 to 42), a significant sire line × plane of nutrition interaction was observed ($P = 0.036$) for fecal score, with pigs from sire line B fed the low plane of nutrition exhibiting a small increase ($P < 0.05$) in fecal score compared with pigs from sire line A, with sire line C being intermediate; however, there were no differences in fecal score among sire lines fed the high plane of nutrition. For fecal scores, in phase 1 (d 0 to 10), phase 2 (d 10 to 21), and overall (d 0 to 42), pigs fed a low nutritional plane had a small improvement ($P \leq 0.002$) in fecal scores compared with pigs fed a high nutritional plane. In summary, offspring from sire lines A and B had improved feed efficiency compared to sire line C, and pigs fed the high plane of nutrition had improved ADG and F/G overall. Interestingly, in the late nursery period, pigs from sire line B fed the low plane of nutrition had a small increase in fecal looseness, with no differences among sire lines fed the high plane of nutrition.

[1] United Animal Health, Sheridan, IN.

[2] Department of Diagnostic Medicine/Pathobiology, College of Veterinary Medicine, Kansas State University.

Effect of Dietary Crude Protein and Acid-Binding Capacity on Growth Performance, Serum Cytokine Concentration, and Intestinal Morphology in Enterotoxigenic Escherichia coli F18 Challenged Nursery Pigs

Jessica L. Smallfield, Jordan T. Gebhardt1, Mike D. Tokach, Jason C. Woodworth, Joel M. DeRouchey, Robert D. Goodband, Katelyn N. Gaffield, Raghavendra G. Amachawadi2, Harith Salih2, Taghreed Mahmood2, Franco Matias Ferreyra3, and Marcelo N. Almeida4

Summary

A total of 80 weanling pigs (241 × 600 DNA; initially 14.1 ± 1.03 lb) were used in a 14-d study using two groups (40 pigs/group) to evaluate effects of crude protein (CP) and acid-binding capacity at a pH of 4 (ABC-4) on growth performance, fecal dry matter (DM), serum cytokines, haptoglobin concentrations, and intestinal morphology in Enterotoxigenic *Escherichia coli* F18 (ETEC)-challenged nursery pigs. Within group, pigs were randomly allotted to one of four dietary treatments in a generalized randomized block design. Diets were corn-soybean meal-based without pharmacological levels of Zn or Cu and arranged in a 2 × 2 factorial treatment design. The first factor, ABC-4, compared a low ABC-4 diet formulation (200 and 250 meq/kg in phases 1 and 2, respectively) to a traditional formulation (TF) concept where the ABC-4 level was not specifically considered (≥ 418 and ≥ 382 meq/kg in phases 1 and 2, respectively). The second factor, CP, was tested at 21% (1.35% SID Lys) and 18% (1.15% SID Lys). There were 20 pigs per dietary treatment and diets were fed from d -7 to 0 (phase 1) and d 0 to 14 (phase 2). Pigs were group housed for a 7-d acclimation period, then moved to individual pens and inoculated with ETEC (d 0). Overall (d 0 to 14), pigs fed low ABC-4 diets tended to have increased ($P = 0.066$) G:F compared with those fed TF diets. No interactions were observed for fecal DM. However, fecal DM increased ($P \leq 0.039$) on d 0 and 10 for pigs fed low ABC-4 diets compared with those fed TF diets, with no differences observed on d 3, 7, or 14. An ABC-4 × day interaction was observed ($P = 0.014$) for serum haptoglobin. Haptoglobin tended to decrease ($P = 0.091$) on d 14 in pigs fed low ABC-4 diets compared to pigs fed diets using a TF strategy, with no differences on d 0 or 7. An ABC-4 × CP × day interaction was observed ($P = 0.050$) for TNFα where on d 14 ($P = 0.003$) pigs fed the low ABC-4 diet at 18% CP had increased TNFα concentrations, while pigs fed the TF diet at 21% CP had increased concentrations. Additionally, ABC-4 × day interactions were observed ($P \leq 0.035$) for pro-inflammatory (IL-1α, IL-2, IL-6, IL-18) and anti-inflammatory (IL-4 and IL-10) cytokines where on d 7 pigs fed low ABC-4 diets had increased ($P \leq 0.036$) concentrations compared to pigs fed TF diets. An ABC-4 × CP interaction was observed ($P = 0.007$) for duodenal crypt depth, where pigs fed the low ABC-4 diet at 21% CP had greater ($P < 0.05$) crypt depth compared with pig fed the low ABC-4 diet at 18%, whereas the opposite trend occurred for TF diets. In summary, using a low ABC-4 diet formulation strategy tended to improve feed efficiency, increased fecal DM, and increased cytokine concentrations in ETEC F18-challenged nursery pigs.

[1] Department of Diagnostic Medicine/Pathobiology, College of Veterinary Medicine, Kansas State University.
[2] Department of Clinical Sciences, College of Veterinary Medicine, Kansas State University.
[3] Veterinary Diagnostic Laboratory, College of Veterinary Medicine, Kansas State University.
[4] Veterinary Diagnostic Laboratory, College of Veterinary Medicine, Iowa State University.

Effect of Nursery Phase Feeding Budget on Growth Performance, Economics, and Fecal Dry Matter in Nursery Pigs Raised Under Commercial Conditions

Julian Arroyave, Mike D. Tokach, Jason C. Woodworth, Joel M. DeRouchey, Robert D. Goodband, Katelyn N. Gaffield, Jordan T. Gebhardt[1], Jorge Estrada[2], Matt Frizzo[2], and Eric Parr[2]

Summary

This experiment was conducted in a commercial research facility to validate the results of a previous study conducted at Kansas State University swine facilities that observed no difference in overall growth performance, but better economic outcomes, when the feed budgets for the more complex diets (phases 1 and 2) were reduced and the simple diet (phase 3) budget increased. A total of 1,170 pigs (initially 12.5 ± 0.70 lb) were randomly assigned to one of three nursery phase feeding budgets under a randomized complete block design. There were 26 pigs per pen and 15 pens per treatment. The feed budgets for high, medium, and low programs were 4, 2, and 0 lb/pig for phase 1 and 12, 8, and 4 lb/pig for phase 2, respectively. All pigs were then fed common phase 3 and 4 diets thereafter. Phase 1 was formulated with specialty animal protein and lactose products and was formulated to contain 18.0% lactose with 16.3% soybean meal. In phase 2, specialty protein sources and the lactose level were reduced, with diets containing 7.2% lactose and 22.5% soybean meal. Phase 3 and 4 diets were corn-soybean meal-based with no specialty protein or lactose sources. Pigs were weighed and feed disappearance was measured on d 0, 7, 14, 21, 33, 42, and 63 to calculate ADG, ADFI, and F/G. Pigs fed the high-budget program tended ($P < 0.10$) to have increased ADG and ADFI during period 2 (d 14 to 33); however, by d 63, no differences between nursery budget programs were observed for any of the response criteria, removals, or mortality. Feed cost and feed cost per lb of gain decreased ($P < 0.001$) as the budget for phases 1 and 2 was reduced. Pigs fed the high-budget program had greater ($P = 0.049$) revenue than those fed the medium-budget program, with intermediate values observed in the low-budget program, which resulted in greater income over feed cost (IOFC; $P = 0.004$) for pigs fed the low-budget program compared with those fed the medium- or high-budget programs. Pigs fed the low-budget program had numerically lower fecal dry matter (DM) compared with pigs fed the medium- or high-budget programs. In conclusion, under commercial conditions, reducing the feed budget amounts of phases 1 and 2 of the nursery feeding program had minimal effects on pig growth performance and lowered feed cost and feed cost per unit of gain, resulting in greater IOFC.

[1] Department of Diagnostic Medicine/Pathobiology, College of Veterinary Medicine, Kansas State University.
[2] Carthage Veterinary Services, Carthage, IL.

Effect of Increasing Dietary Iodine on Nursery Pig Growth Performance

Tomas Porcel de Peralta, Sara Virdis1, Mike D. Tokach, Jason C. Woodworth, Joel M. DeRouchey, Robert D. Goodband, Katelyn N. Gaffield, and Jordan T. Gebhardt1

Summary

A total of 720 barrows (DNA 200 × 400, initially 13.8 ± 0.02 lb) were used in a 46-d study to determine the effects of increasing dietary iodine on growth performance of nursery pigs. At weaning, pigs were randomly assigned within six BW blocks to one of six dietary treatments in a generalized randomized block design. There were five pigs per pen and 24 pens per treatment. Experimental diets were corn-soybean meal-based and were fed for the first 39 d (phase 1 from d 0 to 10, phase 2 from d 10 to 24, and phase 3 from d 24 to 39), and then all pigs were fed a common diet for the last week of the study (d 39 to 46). All diets contained a basal level of 0.3 ppm of added iodine from ethylenediamine dihydriodide provided by the trace mineral premix. To create the dietary treatments, a low-iodine control diet (0.3 ppm of added iodine) and a high-iodine diet (30 ppm added iodine from calcium iodate, 63.5% iodine) were manufactured. The four intermediate dietary treatments (6.2, 12.2, 18.1, and 24 ppm of added iodine) were then produced by proportionally blending the low- and high-iodine diets. During the experimental period (d 0 to 39), there was a cubic response ($P \leq 0.023$) for ADG and ADFI where performance increased from 0.3 to 12.2 ppm, was decreased at 24 ppm, and finally increased at 30 ppm. Feed efficiency during the experimental period and overall improved (linear, $P < 0.05$) as added iodine increased. Overall, from d 0 to 46, there was a cubic response ($P \leq 0.023$) for ADG and ADFI resulting in a tendency (cubic, $P = 0.066$) for a final BW response where performance increased from 0.3 to 12.2 ppm, decreased at 24 ppm, and finally increased at 30 ppm. In conclusion, weaned pigs fed 12.2 ppm iodine in the diet had improved overall body weight, ADG, ADFI, and F/G compared with the basal level of 0.3 ppm added iodine.

[1] Department of Diagnostic Medicine/Pathobiology, College of Veterinary Medicine, Kansas State University.

Effect of Low Crude Protein Formulation Strategies With and Without Pharmacological Zn for Nursery Pigs Challenged With Enterotoxigenic *Escherichia coli* F18

Jentry J. Squires, Payton L. Dahmer, Joel M. DeRouchey, Julian A. Jaramillo, Katelyn N. Gaffield, Joana Magoga, Jason C. Woodworth, Taghreed Mahmood[1], Harith Salih[1], Raghavendra G. Amachawadi1, and Jordan T. Gebhardt[2]

Summary

A total of 90 weanling pigs (DNA 241 × 600; initially 13.2 ± 0.80 lb BW) were used in a 21-d study using two groups (45 pigs/group) to evaluate the effects of low crude protein (CP) formulation strategies with and without pharmacological zinc from zinc oxide (ZnO) on growth performance, fecal dry matter, and health parameters in enterotoxigenic *Escherichia coli* F18 (ETEC)-challenged nursery pigs. Within group, pigs were balanced for sex, stratified by weight, and allotted to one of five dietary treatments in a generalized randomized block design with 9 pigs per treatment (total of 18 replications per treatment). Diets were corn-soybean meal-based and formulated as: high CP (20.7% CP, 1.35% SID Lys), low CP (18.0% CP, 1.17% SID Lys), low CP + AA (18.0% CP, 1.35% SID Lys, similar SID AA:Lys ratios to high and low CP treatments by increasing synthetic AA inclusion), low CP + ZnO (18.0% CP, 1.17% SID Lys, 3,000 ppm Zn from ZnO), and low CP + AA + ZnO (18.0% CP, 1.35% SID Lys, 3,000 ppm Zn from ZnO). Following weaning (~19 d of age) pigs were group housed by treatment (4 or 5 pigs/pen) and provided their respective treatments during the pre-challenge period. Pigs were then moved to individual pens and continued their treatment diet on d 7. Inoculation occurred on d 7 with 6 mL of 10^7 CFU/mL ETEC F18 administered via orogastric gavage and followed with 6 mL of phosphate-buffered saline. Performance measures were collected on d 0, 7, 14, and 21 to calculate ADG, ADFI, and G:F. On d 7, 10, 14, 17, and 21, fecal samples were collected from each pig for determination of fecal dry matter (DM). Overall, after ETEC challenge pigs fed low CP + AA + ZnO had greater ($P < 0.05$) ADG compared with pigs fed the high CP or low CP treatments. Feed intake was greater ($P < 0.05$) for pigs fed low CP + ZnO and low CP + AA + ZnO compared with pigs fed the high or low CP diets. There was no evidence of a difference ($P = 0.640$) in the overall challenge period feed efficiency. There was a treatment × day interaction for fecal DM ($P < 0.0001$). On d 7 and 21, there were no differences in fecal DM between treatments. On d 10, fecal DM was greater ($P < 0.05$) for pigs fed diets containing ZnO. On d 14, pigs fed low CP + AA + ZnO had greater ($P < 0.05$) fecal DM compared with pigs fed the low CP diet. On d 17, pigs fed low CP had greater ($P < 0.05$) fecal DM compared with pigs fed high CP. In summary, inclusion of ZnO, particularly when combined with elevated AA levels in a low CP formulation strategy, enhanced growth performance in ETEC F18-challenged pigs relative to a low CP diet.

[1] Department of Clinical Sciences, College of Veterinary Medicine, Kansas State University.
[2] Department of Diagnostic Medicine/Pathobiology, College of Veterinary Medicine, Kansas State University.

Effects of different pharmacological Zn feeding duration strategies on nursery pig growth performance, fecal dry matter, plasma Zn and Cu concentrations, and final market weight

Joana Magoga1, Jordan T. Gebhardt[1], Robert D. Goodband, Jason C. Woodworth, Joel M. DeRouchey, Katelyn N. Gaffield, and Mike D. Tokach

Summary

Pharmacological levels of Zn from zinc oxide (ZnO) are commonly used in nursery diets to improve growth performance and reduce post-weaning diarrhea. Although the benefits of this strategy during the early nursery phase are well established, less is known about its long-term effects on finishing performance and market weight, particularly when different pharmacological Zn feeding duration strategies are applied. Therefore, this study evaluated the effects of varying pharmacological Zn feeding duration programs on nursery growth performance, fecal dry matter (DM), plasma Zn and Cu concentrations, and subsequent finishing performance. At weaning, 360 pigs (initially 12.5 ± 0.06 lb) were assigned to one of six dietary treatments in a randomized complete block design, with 12 replicate pens per treatment and five pigs per pen. Dietary treatments were applied across three nursery phases (phase 1, d 0 to 11; phase 2, d 11 to 24; phase 3, d 24 to 45), followed by a common diet (phase 4, d 45 to 55). The six dietary treatments included: 1) no pharmacological Zn, with 110 mg/kg Zn provided in the premix from zinc sulfate in all phases; 2) 3,000 mg/kg Zn in phase 1, then 110 mg/kg for phases 2 and 3; 3) 3,000 mg/kg in phase 1, 2,000 mg/kg in phase 2, then 110 mg/kg in phase 3; 4) 3,000 mg/kg in phase 1, 2,000 mg/kg in phase 2, and 1,000 mg/kg for 7 d in phase 3 followed by 110 mg/kg for the remainder of phase 3; 5) 3,000 mg/kg in phase 1, 2,000 mg/kg in phase 2, and 1,000 mg/kg for 14 d in phase 3 followed by 110 mg/kg for the remainder of phase 3, and 6) 3,000 mg/kg in phase 1, 2,000 mg/kg in phase 2, and 1,000 mg/kg throughout phase 3. In phase 4, all pigs received a common diet containing 110 mg/kg of Zn. Pigs were subsequently followed through the finishing period (d 55 to market) and fed a common diet containing 110, 92, and 73 mg/kg of added Zn across finishing phases 1, 2, 3, and 4, respectively. During nursery phase 1, pigs fed pharmacological Zn had greater ADG ($P < 0.001$), ADFI ($P = 0.005$), and better F/G ($P = 0.008$) compared with pigs fed no pharmacological Zn. In phase 2, ADG differed among treatments ($P = 0.005$), with pigs previously fed 3,000 mg/kg Zn and lowered to 110 mg/kg showing decreased performance. No treatment differences were observed during phase 3 or the common nursery period. Body weight was greater ($P < 0.05$) at d 11 and 24 and tended to be greater ($P < 0.10$) at d 31 and 38 for pigs maintained on high Zn levels; however, there was no evidence for differences on d 55. Overall nursery performance (d 0 to 55) was not affected by treatment. Plasma Zn concentration was influenced by treatment over time ($P < 0.001$), reflecting the duration of pharmacological Zn supplementation, whereas plasma Cu concentration was not affected by treatment. Fecal DM was improved in pigs receiving pharmacological Zn during the first nursery phase ($P = 0.002$). During the finishing period, no differences were observed in ADG, ADFI, F/G, or final market weight among previously fed treatments, indicating no carryover effects of nursery pharmacological Zn feeding duration strategy on subsequent growth performance. In conclusion, pharmacological Zn supplementation enhanced growth performance and fecal DM during the early nursery phase; however, these benefits do not persist after removing pharmacological Zn levels from the diet, having no detectable carryover effects on finishing growth performance when pigs were subsequently fed common diets.

[1] Department of Diagnostic Medicine/Pathobiology, College of Veterinary Medicine, Kansas State University.

Effects of Organic Acids and Monoglycerides Supplementation on Growth Performance, Fecal Dry Matter, and Intestinal Morphology of Weanling Pigs Experimentally Infected with Enterotoxigenic *Escherichia coli*

Shannon A. Rossman[1], Jordan T. Gebhardt[1], Sara Virdis[1], Annika Janss, Mike D. Tokach, Jason C. Woodworth, Joel M. DeRouchey, Robert D. Goodband, Katelyn N. Gaffield, Raghavendra G. Amachawadi[2], Harith Salih[2], Taghreed Mahmood[2], Franco Matias Ferreyra[3], and Ying Chen[4]

Summary

A total of 90 weanling pigs (241 × 600 DNA; initially 13.9 ± 0.46 lb) were used in a 10-d study using two groups of pigs (45 pigs/group) to evaluate the effects of organic acids and monoglycerides on growth performance and fecal dry matter (DM) in enterotoxigenic *Escherichia coli* F18 (ETEC)-challenged nursery pigs. Within group, pigs were randomly allotted to one of five dietary treatments in a completely randomized design. There were 18 pigs per dietary treatment, and diets were fed in two phases with phase 1 fed during a 7-d adaptation period before inoculation and phase 2 fed during the 10-d post-inoculation period. Pigs were group-housed for the 7-d acclimation period, then moved to individual pens and inoculated (d 0). Diets were corn-soybean meal-based without pharmacological levels of Zn or Cu and arranged in a one-way treatment structure. Treatment diets were formulated as a basal phase 1 and phase 2 feed and then mixed in smaller batches to include 0.5% of one of the following additives: ground corn (control), ForBen1 (formic/benzoic blend), Acitra G20C, Monoglyceride Mix A (mix of mono-, tri-butyrin and C8C10 monoglycerides), and Monoglyceride Mix B (mix of mono-, tri-butyrin and C8-C12 monoglycerides). There were no effects of dietary treatment on growth performance throughout any period of the study. However, pigs fed Acitra G20C had a numerically increased ADG and ADFI from d 5 to 10 of the experiment and the overall period. Pigs fed Monoglyceride Mix A had the numerically poorest performance across all periods. A main effect of timepoint on fecal DM was observed where DM was improved ($P < 0.05$) on d 0 and 10 compared with d 3, 5, and 7. No interactive effects of dietary treatment and timepoint were observed for fecal DM. No significant treatment effects were observed for villus height, crypt depth, or villus height:crypt depth ratio in the duodenum, jejunum, or ileum. However, a tendency was observed for ileal crypt depth ($P = 0.068$) where pigs fed Monoglyceride Mix A had numerically the smallest crypt depth. Additionally, a tendency for duodenal villus height:crypt depth ratio was observed ($P = 0.072$) where pigs fed Monoglyceride Mix B had numerically the greatest ratio. In conclusion, dietary treatment did not have a significant effect on growth performance, fecal DM, or intestinal morphology of ETEC F18-challenged nursery pigs.

[1] Department of Diagnostic Medicine/Pathobiology, College of Veterinary Medicine, Kansas State University.
[2] Department of Clinical Sciences, College of Veterinary Medicine, Kansas State University.
[3] Veterinary Diagnostic Laboratory, College of Veterinary Medicine, Kansas State University.
[4] Eastman Chemical Company, Kingsport, TN.

Nutritional Interventions with Zinc Source and Copper Level in Low Acid-Binding Capacity-4 Diets for Nursery Pigs as Alternatives to Pharmacological Levels of Zinc Oxide

Juho Lee1, Ron Aldwin S Navales, Mike D. Tokach, Jason C. Woodworth, Joel M. DeRouchey, Robert D. Goodband, Katelyn N. Gaffield, Jordan T. Gebhardt[2], Alessandra Rigo Monteiro[3], Yron Joseph Y. Manaig[3], and Paolo Trevisi[1]

Summary

Pharmacological levels of zinc (Zn) prevent diarrhea and improve the growth performance of nursery pigs, but pose environmental challenges. A total of 360 pigs (241 × 600 DNA; initially 12.5 ± 0.04 lb) were used to investigate effects of Zn source and Cu level in low acid-binding capacity (ABC)-4 diets for nursery pigs as an alternative to pharmacological levels of zinc oxide (ZnO) on growth performance, fecal dry matter (DM), plasma mineral concentrations, apparent total tract digestibility (ATTD) of nitrogen (N) and minerals, and N and minerals balance. At weaning, pigs were randomly assigned within three BW blocks to one of six dietary treatments in a generalized randomized block design. There were five pigs per pen and 12 pens per treatment. Experimental diets were fed in three periods: phase 1 (d 0 to 10), phase 2 (d 10 to 24), and phase 3 (d 24 to 46). Diets were arranged in a 3 × 2 factorial consisting of three Zn treatments and two Cu levels. Zinc treatments involved low (150 mg/kg) or high (800 mg/kg) levels of Zn from potentiated ZnO (pZnO, HiZox, Animine Prevision Minerals, Annecy, France) in both phases 1 and 2, or pharmacological levels of Zn from standard ZnO (Maximo720, Zinc Nacional, Monterrey, Mexico) at 3,000 mg/kg in phase 1 and 2,000 mg/kg in phase 2. Copper was provided as monovalent copper oxide (Cu_2O; CoRouge, Animine) at low (18 mg/kg) or high (150 mg/kg) levels. In phase 3, diets were formulated with either low or high levels of Cu_2O, each containing 150 mg/kg of Zn from pZnO. Basal diets for phases 1 and 2 were low ABC-4 diets with crystalline lactose, fumaric and formic acids, and their ABC-4 levels were 199 and 248 meq/kg, respectively. In phase 3, a conventional diet (437 meq/kg) was used without consideration of ABC-4 levels. In all periods, there were no significant Zn × Cu interactions or Zn effect on growth performance criteria. In the overall period (d 0 to 46), pigs fed high levels of Cu_2O had increased ADG compared with low levels of Cu_2O ($P = 0.049$). There was a tendency for a Zn effect on fecal DM on d 10 ($P = 0.059$) with pigs fed low levels of pZnO having higher fecal DM than pigs fed pharmacological levels of ZnO. The d 24 ATTD of Cu was affected by Zn ($P < 0.001$), with pigs fed pharmacological levels of ZnO showing the lowest ATTD of Cu. In addition, pigs fed high levels of Cu_2O tended to have reduced ATTD of Cu on d 24 ($P = 0.067$) compared with pigs fed low levels of Cu_2O. In conclusion, in low ABC-4 diets, high levels of Zn, regardless of source, did not benefit growth performance, whereas the high levels of Cu_2O improved growth performance. Also, pharmacological levels of Zn from ZnO decreased the ATTD of Cu in pigs fed low ABC-4 diets

[1] Department of Agro-Food Sciences and Technologies, University of Bologna, Bologna, Italy.
[2] Department of Diagnostic Medicine/Pathobiology, College of Veterinary Medicine, Kansas State University.
[3] Animine Prevision Minerals, Annecy, France.

Effects of a Mycelium-derived β-glucan Feed Additive on Nursery Pig Growth Performance, Fecal Dry Matter, and Immune Response

Joana Magoga1, Jason C. Woodworth, Jordan T. Gebhardt1, Robert D. Goodband, Joel M. DeRouchey, Katelyn N. Gaffield, Mike D. Tokach, Peter Karnezos[2] and Chris Zeager[2]

Summary

A study was conducted to evaluate the effects of increasing dietary inclusion of a mycelium-derived β-glucan feed additive on growth performance, fecal dry matter, and cytokine responses in nursery pigs. A total of 360 weanling pigs (initial BW = 12.4 ± 0.06 lb) were used in a 45-d study. At weaning, pigs were blocked by three BW categories (light, medium, and heavy) and within BW category pigs were randomly assigned to one of six dietary treatments in a generalized randomized block design. Each treatment consisted of 12 replicate pens with five pigs per pen. The dietary program was typical of commercially formulated diets and consisted of three feeding phases: phase 1 (d 0 to 10), phase 2 (d 10 to 24), and phase 3 (d 24 to 45). The six treatments were: Control (Ctrl): basal diet across all phases; Ctrl + Carbadox: basal diet supplemented with 55 ppm carbadox in all phases; Low β-glucan: basal diet supplemented with β-glucan at 750, 500, and 250 ppm in phases 1, 2, and 3, respectively; Medium-Low β-glucan: basal diet supplemented with β-glucan at 1,000, 750, and 500 ppm in phases 1, 2, and 3, respectively; Medium-High β-glucan: basal diet supplemented with β-glucan at 1,250, 1,000, and 750 ppm in phases 1, 2, and 3, respectively; and High β-glucan: basal diet supplemented with β-glucan at 1,500, 1,250, and 1,000 ppm in phases 1, 2, and 3, respectively. There was no evidence of treatment differences in BW on d 0 and 10; however, by d 24, pigs fed Carbadox had greater BW than Ctrl pigs ($P = 0.002$), and this response was maintained through d 45, at which time Carbadox-fed pigs had greater BW than Ctrl, Medium-Low, and Medium-High β-glucan pigs ($P < 0.05$) with the Low and High β-glucan pigs intermediate. From d 0 to 10, ADG, ADFI, and F/G were not affected by treatment. From d 10 to 24, ADG and ADFI were greater in Carbadox-fed pigs compared with Ctrl pigs ($P \leq 0.014$), with a tendency for improved F/G ($P = 0.078$) also observed; however, β-glucan level did not impact performance. From d 24 to 45, ADG and ADFI were improved ($P \leq 0.001$) when Carbadox was included in the diet. Although there were no linear or quadratic responses to β-glucan inclusion level, pigs fed the Low and High β-glucan treatments had intermediate ADG and ADFI compared with the Carbadox-fed pigs and the other treatments. Overall (d 0 to 45), Carbadox increased ($P \leq 0.002$) ADG, ADFI, and final BW compared with pigs fed the control diet. There were no linear or quadratic growth performance responses to increasing β-glucan in the diet. The Low β-glucan treatment had an intermediate ADG response compared with the Carbadox-fed pigs and the other treatments. For ADFI, all β-glucan treatments were intermediate compared with the Ctrl and Carbadox treatments and for F/G the Low and High β-glucan treatments were intermediate compared with the Carbadox treatment and all other treatments. Treatment affected fecal DM on d 24 and 45 ($P < 0.001$), with Carbadox-fed pigs having greater fecal DM than the Medium-Low β-glucan pigs on d 24 ($P < 0.05$) and greater than all other treatments on d 45 ($P < 0.05$). No linear or quadratic effects of β-glucan inclusion were observed for fecal

1 Department of Diagnostic Medicine/Pathobiology, College of Veterinary Medicine, Kansas State University.

2 Primient, Schaumburg, IL.

DM. Carbadox-fed pigs also had lower CRP on d 24 compared with Ctrl and Medium-High β-glucan pigs ($P < 0.05$) and lower haptoglobin compared with Ctrl and all β-glucan treatments ($P < 0.05$), although these effects were not maintained on d 45. Treatment affected cytokine responses, including increased GM-CSF ($P < 0.05$) in pigs fed Medium-High β-glucan compared with Medium-Low and Low β-glucan on d 45. Interferon-γ (IFN-γ) was also affected by treatment on d 45 ($P = 0.035$), although no mean separation was detected. A linear effect of β-glucan inclusion was observed for IFN-γ ($P = 0.019$) and a quadratic effect for IL-12 ($P = 0.044$). No treatment effects were observed for other cytokines. In conclusion, carbadox improved growth performance, fecal DM, and reduced inflammatory markers, whereas mycelium-derived β-glucan supplementation influenced selected immune parameters with the low level of β-glucan resulting in overall ADG and ADFI similar to that of both the control and carbadox treatments in this high-health environment. Additional research in a commercial barn may be warranted, especially with the low β-glucan treatment to determine if the ADG and ADFI benefits can be repeated.

Determining the Effects of Formyl Inclusion Strategy on Nursery Pig Growth Performance and Fecal Dry Matter

Cooper McAuley, Jordan T. Gebhardt1, Jason C. Woodworth, Katelyn N. Gaffield, Joel M. DeRouchey, Dwight J. Shawk[2], and Victor Perez[3].

Summary

A total of 2,560 pigs (PIC 337 × 1050, initial BW 11.8 ± 0.44 lb) were used in a 45-d growth trial to determine the effects of Formyl, an encapsulated form of calcium formate and citric acid, inclusion strategy on nursery pig growth performance and fecal dry matter (DM). Pens were assigned to one of four treatments in a randomized complete block design with BW as a blocking factor. There were 20 replicate pens per treatment and 32 pigs per pen. The experimental diets were corn-soybean meal-based and were fed in three phases. There were four feeding program treatments consisting of 1) 0% Formyl inclusion for all phases, 2) 0.25% Formyl inclusion for all phases, 3) 0.50% Formyl inclusion for all phases, or 4) 0.50% Formyl inclusion for phases 1 and 2, followed by 0.25% inclusion for phase 3. Phase 1 had a feed budget of 4 lb/pig, phase 2 approximately 10.5 lb/pig, and phase 3 was provided for the remainder of the experiment. From d 0 to 10, ADFI decreased and then increased (quadratic, $P = 0.011$) with increasing Formyl inclusion, but there was no evidence ($P > 0.10$) of differences for ADG and F/G. From d 10 to 17, there was a linear increase in ADG ($P = 0.010$) resulting in a tendency for increased BW on d 17 (linear, $P = 0.078$) and d 24 (linear, $P = 0.071$) with increasing Formyl inclusion. From d 24 to 31, there was a tendency for worsened ADG (linear, $P = 0.072$) and F/G (linear, $P = 0.085$) with increasing Formyl inclusion. During d 31 to 45, respiratory health challenges were observed in the research facility as noted by the reduced intake and gain compared with d 24 to 31. During d 31 to 45, there was a tendency (linear, $P = 0.100$) for increased ADG as Formyl inclusion increased. There were no differences in growth performance between the treatment fed 0.5% Formyl throughout the trial and the treatment fed 0.5% in phases 1 and 2 and then 0.25% in phase 3. There were no differences in overall (d 0 to 45) growth performance between treatments. Feed cost per pig placed and feed cost per lb gain increased (linear, $P \leq 0.001$) as Formyl inclusion increased. No differences were observed in total revenue or IOFC. In conclusion, Formyl demonstrated modest benefits in growth performance in the early nursery period, and the data suggest that in times of lower health status feeding Formyl may mitigate some of the negative impact on growth performance.

[1] Department of Diagnostic Medicine/Pathobiology, College of Veterinary Medicine, Kansas State University.
[2] Hord Family Farms, Bucyrus, OH.
[3] Kemin Industries, Des Moines, IA.

Effects of Oregano Essential Oil and Zinc Oxide on Nursery Pig Growth Performance, Apparent Crude Protein and Dry Matter Digestibility, and Fecal Dry Matter

Jessica L. Smallfield, Paige T. Soper, Joel M. DeRouchey, Jordan T. Gebhardt[1], Jason C. Woodworth, Katelyn N. Gaffield, Phil Burke[2], and Heidi N. Hall[2].

Summary

A total of 375 weanling pigs (DNA 600 × 241; initially 12.8 ± 0.03 lb) were used in a 42-d study to evaluate the effects of an oregano essential oil in water or feed on growth performance, digestibility of crude protein (CP) and dry matter (DM), and fecal dry matter in nursery pigs. Pens of pigs were randomly allotted to one of five dietary treatments in a generalized randomized block design with five pigs per pen and 15 pens per treatment (five replications per BW category). Diets were corn-soybean meal-based and arranged in a 2 × 2 + 1 factorial. Main effects were no added or added pharmacological levels of Zn (ZnO added to achieve Zn levels of 3,000 and 2,000 ppm in phases 1 and 2, respectively) and no added Orego-Stim Plus Liquid 2X (OSPL; Anpario, Worksop, United Kingdom) or added Orego-Stim Plus Liquid 2X provided through the drinking water system (delivered at a final dilution of approximately 1:8,000). The additional treatment included 0.03% of Orego-Stim Plus Powder 2X (OSPP; Anpario, Worksop, United Kingdom) in the feed without pharmacological Zn. Thus, the five treatments consisted of 1) positive control (PC) with pharmacological levels of Zn; 2) negative control (NC) without pharmacological levels of Zn; 3) PC + OSPL; 4) NC + OSPL; and 5) NC + OSPP. Treatment diets were fed in three phases from d 0 to 10 (phase 1), d 10 to 24 (phase 2), and d 24 to 42 (phase 3). On d 0 and 42, a serum sample was collected from the same gilt per pen for *Mycoplasma hyopneumoniae* S/P ratios. On d 10 and 21, fecal samples were collected from the same three randomly selected pigs in each pen to determine fecal DM. Additionally on d 21, fecal samples were used to determine the apparent total tract digestibility (ATTD) of DM and CP. During phase 1 (d 0 to 10), pigs fed diets containing pharmacological levels of Zn from ZnO had increased ADG ($P = 0.046$) and tended to have increased ADFI and d 10 BW ($P \leq 0.080$) compared with pigs fed diets without ZnO. During phase 2 (d 10 to 24), a similar response was observed where pigs fed diets containing pharmacological levels of Zn from ZnO had increased ADG, ADFI, and d 24 BW ($P \leq 0.001$) compared with pigs fed diets without ZnO. Additionally, pigs fed the PC diet had increased ADG, ADFI, and BW ($P < 0.05$) compared with pigs fed NC + OSPP. There were no differences in phases 1 or 2 when OSPL was added in the water. In phase 3 (d 24 to 42), pigs previously fed ZnO had reduced ADG and worsened F/G ($P \leq 0.041$) compared with pigs not previously fed pharmacological levels of Zn. Furthermore, pigs previously fed the PC tended to have decreased ($P < 0.10$) ADG compared with pigs fed the NC + OSPP. Overall (d 0 to 42), feeding pharmacological levels of Zn in phases 1 and 2 did not result in overall performance differences. Additionally, no significant differences were observed for OSPL. For fecal DM, a tendency for an NC + OSPL versus NC + OSPP × day interaction was observed ($P = 0.068$), where pigs fed NC + OSPP had greater fecal DM on d 10 ($P = 0.024$), with no difference observed on d 21. Zinc oxide

[1] Department of Diagnostic Medicine/Pathobiology, College of Veterinary Medicine, Kansas State Universiy.
[2] Anpario plc (Worksop, Nottinghamshire, UK).

increased ATTD of DM and CP ($P < 0.001$), whereas pigs receiving OSPL had lower CP digestibility ($P = 0.015$) and tended to have lower DM digestibility ($P = 0.090$) than those without OSPL. Additionally, pigs fed NC + OSPP had increased ($P < 0.001$) ATTD of DM and CP compared with pigs receiving the NC and NC + OSPL. No significant treatment differences were observed for *M. hyopneumoniae* S/P ratios. In conclusion, pharmacological ZnO improved early nursery growth performance and digestibility, but OSPL resulted in no benefits. Additionally, NC + OSPP resulted in greater fecal DM during the early nursery and improved digestibility compared with NC + OSPL. Further research is warranted under commercial settings.

Evaluation of a Polyphenol as a Partial Replacement for Vitamin E in Nursery Pig Diets

Sierra M. Collier, Joel M. DeRouchey, Jason C. Woodworth, Katelyn N. Gaffield, Ivan D. Girard[1], Yulin Ma[2], and Jordan T. Gebhardt[3]

Summary

A total of 300 barrows (DNA 200 × 400; initially 14.1 ± 0.09 lb) were used in a 42-d growth trial to evaluate the effects of vitamin E levels and partially replacing vitamin E with a polyphenol (Boreox BX050; Probiotech International, Saint-Hyacinthe, QC, Canada) on growth performance, serum vitamin E, thiobarbituric acid reactive substances (TBARS), superoxide dismutase (SOD), and glutathione peroxidase (GSH-PX). Sixty pens of pigs were weighed and allotted to one of four dietary treatments in a completely randomized design with 15 pens per treatment. A control diet was formulated to provide 15 IU/kg of vitamin E. The second diet provided an additional 60 IU/kg of vitamin E for a total of 75 IU/kg of vitamin E. The second diet was then used as a base for two replacement strategy diets to determine the effects of replacing the additional 60 IU/kg of vitamin E with a polyphenol. For the first replacement strategy diet, 50% of the additional vitamin E (30 IU/kg) was replaced with the polyphenol to achieve the same vitamin E equivalence. For the second replacement strategy diet, all 60 IU/kg of the additional vitamin E was replaced with the polyphenol to achieve the same vitamin E equivalence. The vitamin E form used in this trial was DL-α-tocopherol acetate and Boreox was estimated to provide 50% vitamin E equivalency. Experimental diets were fed in three phases: phase 1 from d 0 to 10, phase 2 from d 10 to 22, and phase 3 from d 22 to 42. Blood samples were collected on d 10 and 42 to determine serum vitamin E, TBARS, SOD, and GSH-PX. For growth performance, there were no differences from d 0 to 10 in ADG, ADFI, or feed efficiency. From d 10 to 22, there was a tendency ($P = 0.063$) for a treatment effect on ADG, but the means did not separate. From d 22 to 42 and overall, there was no evidence of differences for ADG, ADFI, or F/G between treatments. There was a treatment × day interaction ($P < 0.001$) observed for serum vitamin E concentration. There were no differences in serum vitamin E on d 10; however, on d 42, pigs fed either diet containing 15 mg/kg vitamin E had the lowest ($P < 0.05$) serum vitamin E concentration, followed by pigs fed 45 mg/kg, whereas pigs fed 75 mg/kg had the greatest serum vitamin E concentration. Additionally, serum vitamin E concentrations were greater ($P < 0.001$) on d 42 compared with d 10, indicating that treatment differences in vitamin E status became apparent only after prolonged dietary exposure. However, there was a tendency ($P = 0.100$) for a treatment effect on serum TBARS on d 10, but the means did not separate. Despite the difference observed for serum vitamin E concentration, there was no evidence of treatment × day interactions or treatment effects for all serum antioxidant measurements. There was a main effect of day ($P < 0.05$) for TBARS and SOD and there tended to be a main effect of day ($P = 0.097$) for GSH-PX, with all serum measurements being greater on d 42 than on d 10. In conclusion, pigs provided additional vitamin E or a combination of vitamin E and polyphenol did not exhibit a growth or antioxidant status response above the 15 IU/kg vitamin E, which is estimated to be the requirement. However, a tendency for a treatment effect on ADG in phase 2 was found, and overall pigs fed 75 IU/kg vitamin E or the polyphenol replacing 100% of the additional 60 IU/kg of vitamin E were 0.9 lb heavier at the end of the study compared with those fed the diet containing vitamin E at the estimated requirement.

[1] Probiotech International, Saint-Hyacinthe, QC, Canada.
[2] Hanley International LLC, Belmont, MA.
[3] Department of Diagnostic Medicine/Pathobiology, College of Veterinary Medicine, Kansas State University.

Effect of Feeding Duration of Elevated Iodine Diets on Growth Performance in Nursery Pigs

Sara Virdis1, Tomás Porcel de Peralta, Katelyn N. Gaffield, Jordan T. Gebhardt1, Joel M. DeRouchey, Jason C. Woodworth, Robert D. Goodband, and Mike D. Tokach

Summary

A total of 720 barrows (DNA 200 × 400; initially 13.6 ± 0.09 lb) were used in a 38-d trial. Two groups of pigs were used with 360 pigs each. In total, 144 pens were used, with five pigs per pen. Pens were randomly assigned to one of four dietary treatments with 36 replicates/treatment. Treatment diets were fed in three phases, phase 1 (d 0 to 10), phase 2 (d 10 to 24), and phase 3 (d 24 to 38). Treatment 1 included 0.3 ppm added iodine throughout the three phases; treatment 2 included 12.2 ppm added iodine during phase 1 and 0.3 ppm added iodine during phases 2 and 3; treatment 3 included 12.2 ppm added iodine during phases 1 and 2, and 0.3 ppm added iodine during phase 3; and treatment 4 included 12.2 ppm added iodine throughout all three phases. Individual body weights and feeder weights were collected on d 0, 10, and then weekly thereafter to calculate ADG, ADFI, and F/G. Across all dietary phases and overall (d 0 to 38), no differences in ADG and, consequently, BW, were observed between treatments. The lack of differences in ADG was consistent with the absence of treatment differences in ADFI and F/G. The lack of consistency between the present study and previous literature is not entirely clear. These data highlight the need for further research to clarify the biological relevance of feeding increased iodine and its duration throughout the nursery period.

[1] Department of Diagnostic Medicine/Pathobiology, College of Veterinary Medicine, Kansas State University.

Effect of Pellet Die Thickness on the Standardized Ileal Digestibility of Crude Protein and Amino Acids in Commercial Diets Fed to Growing Pigs

Diego A. Lopez[1], Matt D. Miesner[2], Jordan T. Gebhardt[3], Charles R. Stark[1], and Chad B. Paulk[1]

Summary

A total of 12 barrows (DNA 241 × 600; initially 169.95 ± 7.79 lb) were surgically fitted with a T-cannula in the distal ileum and allotted to a replicated 4 × 4 Latin square design with four treatments and four periods, for a total of 12 replicate pigs per treatment. Pigs were individually housed in pens equipped with a feeder, nipple drinker, fully slatted metal floor, and smooth side walls. Dietary treatments consisted of a mash diet and three separate diets that were pelleted using different pellet die length:diameter ratios (L:D) of 6 (1.04- × 0.17-in), 8 (1.38- × 0.17-in), and 10 (1.72- × 0.17-in). For each experimental period, the first 5 d were considered adaptation to the diet and the next 2 d were considered the collection period, where ileal digesta was collected for 8 h each day. Results indicate that the standardized ileal digestibility (SID) of crude protein was greater ($P < 0.05$) in the diet pelleted using the L:D 10 die, compared to the mash diet and the diet pelleted using the L:D 6 die, however, no differences were observed between the diets pelleted using the L:D 8 and 10 dies, or between mash diet and the diet pelleted using the L:D 6 die. The SID of amino acids was greater ($P < 0.05$) in the pelleted diets using the L:D 8 and 10, compared with the mash diet and the pelleted diet using the L:D 6 die. However, no differences were observed between the L:D 6 diet and the mash diet. The SID of Lys was greater ($P < 0.05$) in the pelleted diet using the L:D 10 die when compared with the mash diet, with the L:D 6 and 8 diets being intermediate. The SID of Met was greater ($P < 0.05$) in the diets pelleted with the L:D 8 and 10 die, compared with the mash diet, whereas no differences were observed in the SID of Met between the mash diet and the diet pelleted using the L:D 6 die. Similarly, no differences were observed in the SID of Met between the pelleted diets using the L:D 6 and 8 dies. The SID of Trp and Gly was greater ($P < 0.05$) in the diet pelleted using the L:D 8 die compared with the L:D 6, with all other treatments being intermediate. The results indicate that the degree of improvement in SID of crude protein and amino acids is dependent on pellet die thickness due to the differences in temperature, pressure, and friction that the feed is exposed to during the formation of the pellets.

[1] Department of Grain and Food Science, Kansas State University.
[2] Department of Clinical Sciences, College of Veterinary Medicine, Kansas State University.
[3] Department of Diagnostic Medicine/Pathobiology, College of Veterinary Medicine, Kansas State University.

The Apparent Ileal Digestibility and Standardized Ileal Digestibility of Crude Protein and Amino Acids in Corn, White Sorghum, and Red Sorghum Fed to Growing Pigs

Walter G. Friesen[1], Diego A. Lopez[1], Jason C. Woodworth[2], Jordan T. Gebhardt[3], Matt D. Miesner [3], and Chad B. Paulk[1]

Summary

An experiment was conducted to determine the apparent ileal digestibility (AID) and standardized ileal digestibility (SID) of crude protein (CP) and amino acids (AA) in corn, white sorghum, and red sorghum. Twelve barrows were surgically fitted with a T-cannula at the distal ileum and were randomly allotted to a replicated 3 × 3 Latin square design with three diets and three periods for the determination of AID and SID of CP and AA. Previously published values of basal endogenous losses were used to calculate the SID of CP and AA. Treatments consisted of diets containing corn, white sorghum, or red sorghum as the sole source of dietary protein. Data were analyzed using the GLIMMIX procedure of SAS (v. 9.4, SAS Institute, Inc., Cary, NC) as a replicated completely randomized Latin square design. There was an overall grain effect ($P < 0.030$) for SID of Arg, His, Leu, Lys, Met, Phe, Val, Asp, Glu, Tyr, and total indispensable AA. Corn had increased ($P < 0.05$) SID of His and Met compared with red or white sorghum. Red sorghum and corn were similar in SID of Leu, Lys, and Glu, however, both had increased ($P < 0.05$) SID of Leu, Lys, and Glu compared with white sorghum. Corn had increased ($P < 0.05$) SID of Arg, Phe, Val, Tyr, and total indispensable AA compared with white sorghum; however, red sorghum did not differ from corn or white sorghum. Red sorghum had increased ($P < 0.05$) SID of Asp compared with white sorghum; however, corn did not differ from red or white sorghum. There was a tendency ($P < 0.10$) for a treatment effect with red sorghum and corn having numerically greater SID of Ile and Ala compared with white sorghum. Red sorghum tended to have increased ($P = 0.077$) SID of Trp compared with white sorghum. No differences were observed in SID of CP or the remaining indispensable or dispensable AA. In conclusion, corn and red sorghum were similar in SID of most AA when fed to pigs and both had improved digestibility compared with that of white sorghum.

[1] Department of Grain Science and Industry, Kansas State University.
[2] Department of Animal Sciences and Industry, Kansas State University.
[3] Department of Diagnostic Medicine/Pathobiology, College of Veterinary Medicine, Kansas State University.

The Apparent and Standardized Ileal Digestibility of Crude Protein and Amino Acids of Sorghum Produced in Different Regions of the United States fed to Growing Pigs

Walter G. Friesen[1], Diego A. Lopez 1, Jason C. Woodworth[2], Jordan T. Gebhardt[3], Matt D. Miesner[4], Chad B. Paulk[1]

Summary

An experiment was conducted to determine the apparent ileal digestibility (AID) and standardized ileal digestibility (SID) of crude protein (CP) and amino acids (AA) in sorghum grain produced across the U.S. when fed to growing-finishing pigs. Five regionally based sources of sorghum were collected and fed to pigs as the sole source of dietary protein. Twelve barrows were surgically fitted with a T-cannula at the distal ileum and were randomly allotted to a replicated 6 × 6 Latin square with six diets and six periods, providing 12 replicates per treatment. Previously published values of basal endogenous losses were used to calculate the SID of CP and AA. Treatments consisted of diets containing corn; corn from Manhattan, KS (CKS), or sorghum sourced from varying locations; Trenton, NE (SNE); Leoti, KS (SKS1); Fowler, KS (SKS2); Brandon, CO (SCO); and Montgomery City, MO (SMO). There was an overall grain source effect ($P \leq 0.005$) for SID of His, Ile, Leu, Met, Phe, Trp, Val, Ala, Cys, Glu, Ser, and Tyr. Corn had increased ($P < 0.05$) SID of His compared with all sorghum sources. However, sorghum sources did not differ in SID of His. Corn and sorghum sourced from SMO had increased ($P < 0.05$) SID of Ile compared with SNE, with all other sorghum sources being intermediate. Corn and sorghum from SMO had increased ($P < 0.05$) SID of Leu compared with SNE and SCO, with remaining sources being intermediate. Corn had increased ($P < 0.05$) SID of Met compared with all sorghum sources. Sorghum sourced from SMO had increased ($P < 0.05$) SID of Met compared with SCO with all other sources being intermediate. Corn had increased ($P < 0.05$) SID of Phe compared with SNE and SCO. Sorghum from SMO had increased ($P < 0.05$) SID of Phe compared with SNE with remaining sources being intermediate. Corn had decreased ($P < 0.05$) SID of Trp compared with SKS1 and SMO. Sorghum from SMO had increased ($P < 0.05$) SID of Trp compared with SNE with SKS1, SKS2, and SCO being intermediate. Corn had increased ($P < 0.05$) SID of Val compared with SNE, SKS2, and SCO, but was similar to SKS1 and SMO. Sorghum sourced from SMO had the greatest ($P < 0.05$) SID of Val and SNE had the lowest, with the remaining sources being intermediate. The SID of CP and AA was within expected ranges for corn and sorghum; however, SNE generally had lower SID within the sorghum sources. The SID concentration of CP and most AA was generally reduced for sorghum from SMO due to the lower CP and AA content of the grain source compared with other sorghum sources. Consequently, the growing conditions of Missouri may provide lower total AA supply, but improved digestibility to pigs compared with other growing regions.

[1] Department of Grain Science and Industry, Kansas State University.
[2] Department of Animal Sciences and Industry, Kansas State University.
[3] Department of Diagnostic Medicine/Pathobiology, College of Veterinary Medicine, Kansas State University
[4] Department of Clinical Sciences, College of Veterinary Medicine, Kansas State University.

Effects of a Dried Distillers Grains with Solubles Withdrawal Strategy on Grow-Finish Growth Performance, Carcass Characteristics, and Economics

Joana Magoga[1], Dwight Shawk[2], Jordan T. Gebhardt[1], Robert D. Goodband, Jason C. Woodworth, Joel M. DeRouchey, Katelyn N. Gaffield, and Mike D. Tokach

Summary

A study was conducted to evaluate the effects of a DDGS withdrawal strategy on grow-finish pig growth performance and carcass characteristics. A total of 2,133 pigs (PIC 337 × 1050; initially 52.4 ± 0.88 lb) were used in a 120-d trial. Pens of pigs (27 pigs/pen) were blocked by body weight (BW) and randomly assigned to one of four dietary treatments in a randomized complete block design. The four treatments consisted of varying DDGS inclusion and withdrawal strategies across six dietary phases: A) corn-soybean meal-based diet with no DDGS in phases 1 to 6; B) 20% DDGS in phases 1 to 4, and no DDGS (corn-soybean meal) in phases 5 and 6 (20%-0%); C) 20% DDGS in phases 1 to 3, and 10% DDGS in phases 4 to 6 (20%-10%); and D) 30% DDGS in phases 1 and 2, 20% DDGS in phases 3 and 4, and 5% DDGS in phases 5 and 6 (30%-20%-5%). Experimental diets were formulated to maintain a constant SID Lys:NE ratio across treatments. Overall (d 0 to 120), pigs fed a corn-soybean meal-based diet had greater ($P < 0.05$) ADG than pigs fed 30%-20%-5% DDGS, with pigs fed 20%-0% and 20%-10% intermediate. No differences were observed for ADFI across treatments. Feed efficiency improved for pigs fed the corn-soybean meal diet compared with the three withdrawal strategies ($P < 0.05$). Final BW tended to differ among treatments ($P = 0.051$), with pigs fed a corn-soybean meal-based diet having the numerically greatest final BW and pigs fed 30%-20%-5% DDGS the lowest. No differences were observed for removals, mortality, hot carcass weight, carcass yield, backfat depth, loin depth, percentage lean, or revenue across different treatments. Feed cost per pound of gain was lower ($P < 0.05$) for pigs fed the 20%-10% DDGS diet compared with pigs fed the corn-soybean meal diet, with the 20%-0% and 30%-20%-5% DDGS strategies being intermediate. Income over feed cost on a per pig placed basis tended ($P = 0.091$) to be greater for pigs fed the 20%-10% DDGS program compared with pigs fed 30%-20%-5% DDGS, with the corn-soybean meal-based diet and the 20%-0% DDGS diet intermediate. In conclusion, although pigs fed a corn-soybean meal diet had the greatest final BW and best F/G, DDGS withdrawal strategies reduced feed costs while maintaining comparable economic outcomes and carcass characteristics under the ingredient prices used in this study.

[1] Department of Diagnostic Medicine/Pathobiology, College of Veterinary Medicine, Kansas State University.
[2] Hord Family Farms, Bucyrus, OH.

Effects of Sire Line, Creep Feeding, and Plane of Nursery Nutrition on Growth Performance, Carcass Characteristics, Economics, and Removals and Mortalities of Finishing Pigs

Jacob I. Knoy, Joel M. DeRouchey, Katelyn N. Gaffield, Jason C. Woodworth, Christopher L. Puls[1], Rebecca Pritchett[1], Eric Nyberg[1], Sarah Harwood[1], Matthew J. Ritter[1], and Jordan T. Gebhardt[2]

Summary

A total of 1,416 pigs (sire line × PIC 1050) were used in a 119-d trial to determine the effect of sire line, creep feeding, and plane of nursery nutrition on growth performance, carcass characteristics, economics, and removals and mortalities of finishing pigs from sows that had a natural porcine respiratory and reproductive syndrome virus (PRRSV) challenge during gestation. At approximately 19 d of age, pigs were weaned, blocked by sire line and creep feed treatment and sex, then balanced for weight, and allotted to one of two dietary treatments in a randomized complete block design. Treatments were arranged in a 3 × 2 × 2 factorial with main effects of sire line, lactation creep feeding (with or without), and nursery plane of nutrition. Sire line treatments were Pietrain- or Duroc-based, with sire line A being from a Pietrain sire line and sire lines B and C being from Duroc sires. Treatment diets in phases 1 and 2 of the nursery were corn-soybean meal-based with two levels of SID Lys, 1.30% and 1.50%, and formulated with more specialty protein ingredients in the 1.50% SID Lys diet than the 1.30% SID Lys diet. On d 36 of the nursery period, pigs were individually weighed and allotted to pens in the finisher facility, balancing for weight and accounting for previous treatment, with either 19 or 21 pigs per pen and six replicates per treatment. Pigs were placed on a common five-phase feeding program for the grow-finish period. On d 91, 105, and 119, seven pigs per pen were selected by the farm staff, weighed, removed, and transported for harvest. No significant sire line × creep feed × plane of nursery nutrition or sire line × creep feed interactions were observed throughout the finisher portion of the trial. Premarket (d 0 to 91), a significant sire line × plane of nursery nutrition interaction was observed ($P = 0.018$) for F/G, with pigs fed the low plane of nutrition from sire line A exhibiting improved ($P < 0.05$) F/G compared with pigs fed the low nutritional plane from sire lines B and C, with sire line B demonstrating improved F/G compared with sire line C; however, no differences in sire lines were observed with the high plane of nutrition. Overall (d 0 to 119), offspring from sire line A had improved ($P < 0.05$) ADG and F/G compared with offspring from sire lines B and C. Offspring from sire line A had decreased ($P < 0.05$) mortalities and total removals and mortalities compared with offspring from sire lines B and C. For carcass characteristics, a significant main effect of sire line was observed ($P < 0.05$) for HCW and percent yield, with pigs from sire line A demonstrating improved HCW and percent yield compared with pigs from sire line C, with pigs from sire line B being intermediate. Offspring from sire line A had improved ($P < 0.05$) a ADG and carcass F/G compared with pigs from sire lines B and C. Pigs previously provided creep feed had greater ($P = 0.034$) backfat and lower ($P = 0.012$) percent lean compared with pigs not provided creep feed. Pigs from sire line A had greater ($P < 0.05$) IOFC compared with pigs from sire lines B and C. In summary, before marketing, pigs fed a low plane of nursery nutrition from sire line A had improved F/G compared with sire lines B and C, with sire line B exhibiting improved F/G compared with sire line C; however, when pigs were fed a high plane of nursery nutrition, there were no differences between sire lines. Overall, offspring from sire line A had improved ADG and F/G, carcass characteristics, removals and mortality, and IOFC compared with sire lines B and C.

[1] United Animal Health, Sheridan, IN.

[2] Department of Diagnostic Medicine/Pathobiology, College of Veterinary Medicine, Kansas State University.

Effect of In-Feed Antibiotics on the Amount of Injectable Treatments and Total Antibiotic Usage in Finishing Pigs

Paige T. Soper, Joana Magoga[1], Katelyn N. Gaffield, Jordan T. Gebhardt[1], Robert D. Goodband, Mike D. Tokach, Jason C. Woodworth, and Joel M. DeRouchey

Summary

A total of 341 pigs (241 × 600 DNA; initially 77.8 ± 0.62 lb) were used to evaluate whether short-term dietary inclusion of chlortetracycline (CTC) + tiamulin during the first 14 d after placement into the finishing facility influenced the amount of injectable treatments, total antibiotic usage, and growth performance until marketing. Pigs were placed into 36 pens (8 to 10 pigs/pen) with 18 replicates per treatment. Pens were randomly assigned to either a non-medicated control diet or the control diet that was medicated with 400 g/ton CTC + 35 g/ton tiamulin for the first 14 d after placement. After d 14, all pens received a common diet. All injectable antibiotic treatments were administered according to the farm's standard operating procedure, with farm staff blinded to dietary treatments to prevent bias to individual treatment application. For treatment of lameness, an initial dose of dexamethasone (0.22 mg/kg) and lincomycin (11.1 mg/kg) were provided via intramuscular injection, followed by daily injections of lincomycin (11.1 mg/kg) for an additional 2 to 4 d until lameness was resolved. Injections were analyzed as number of treatment regimens initiated per 1,000 pig days and number of individual injections per 1,000 pig days. From d 0 to 14, pigs fed diets containing CTC + tiamulin tended to have fewer injection regimens initiated ($P = 0.081$) and had fewer individual injections ($P = 0.001$) than control pigs. Overall (d 0 to 99), there was no evidence of a difference in the number of treatment regimens initiated ($P = 0.371$) or number of individual injections ($P = 0.127$). Pigs fed CTC + tiamulin had increased ADG ($P = 0.001$) and improved F/G ($P = 0.001$) from d 0 to 14. However, over the entire 99-d study, no differences in ADG or F/G were observed. Still, the increased ADG in the early finishing phase led to a 2.6 lb heavier pig by d 99, although increased variation as pigs grew resulted in the difference not being statistically significant. Incorporating CTC + tiamulin into the diet increased total antibiotic usage by 12,611 mg/pig ($P < 0.0001$) and total cost per pig by $1.12 ($P < 0.0001$). In conclusion, incorporating CTC + tiamulin in the early finishing phase can help reduce the need for injectable antibiotics and the associated labor and improve growth performance during the medication feeding period. However, it also substantially increases overall antibiotic usage and total cost per pig, making the decision to use feed-grade antimicrobials situation-specific depending on the health status and production goals. These data highlight the importance of data interpretation when making animal health decisions and should be used to guide judicious use of antimicrobials in swine production.

[1] Department of Diagnostic Medicine/Pathobiology, College of Veterinary Medicine, Kansas State University.

Effects of Standardized Ileal Digestible Lysine to Crude Protein Ratio on Growth Performance of 163 to 214 lb Pigs

Jessica L. Smallfield, Ron Aldwin S. Navales, Joel M. DeRouchey, Jordan T. Gebhardt1, Jason C. Woodworth, Katelyn N. Gaffield, Mike D. Tokach, and Robert D. Goodband

Summary

Recent evidence in late nursery and finishing pigs has suggested that nitrogen may become limiting for synthesis of nonessential amino acids in low-protein, amino acid-fortified diets. A previous experiment by Navales et al.2 using finishing pigs of various stages of growth observed that cubic models provided the best fit for body weight (BW) ranges of 100 to 153 lb, 121 to 172 lb, and 228 to 275 lb to estimate standardized ileal digestible lysine to crude protein (SID Lys:CP) ratios to optimize F/G based on the local minimum. However, for pigs weighing 187 to 238 lb, the requirement was estimated to be below 5.13%, the lowest SID Lys:CP ratio tested based on the linear model. Therefore, a 21-d study was conducted using a total of 693 pigs (241 × 600 DNA; initially 163.3 ± 1.46 lb) to determine the effect of SID Lys:CP on growth performance and blood urea nitrogen (BUN) of 163 to 214 lb pigs using ratios of 77.5 to 107.5% of the NRC (2012) rather than the 85.0 to 115.0% tested by Navales et al.2. Pens of pigs were blocked by BW and randomly assigned to one of five dietary treatments in a randomized complete block design. There were 9 to 10 pigs per pen and 14 replications per treatment. Dietary treatments were corn-soybean meal-based and formulated to contain 0.71% SID Lys. Treatments provided SID Lys:CP ratios of 77.5, 85.0, 92.5, 100.0, and 107.5% of requirement estimates calculated from NRC (2012) resulting in SID Lys:CP ratios of 4.68, 5.13, 5.58, 6.03, and 6.49%, respectively. Intermediate SID Lys:CP levels were achieved by blending diets with the lowest and highest SID Lys:CP ratio. Pen weights, number of pigs per pen, and feed deliveries were recorded to calculate ADG, ADFI, and F/G. Blood samples were collected on d 14 after a 10-h fasting period from one gilt and two barrows per pen and analyzed for serum BUN. Dose-response curves were evaluated using linear, quadratic polynomial, cubic polynomial, and broken-line linear (BLL) models. Overall (d 0 to 21), increasing SID Lys:CP had no effect on ADG or final BW. A cubic response was observed (P = 0.004) for ADFI, where ADFI decreased when increasing SID Lys:CP from a ratio of 4.68 to 5.13%, then increased up to a SID Lys:CP ratio of 6.03%, followed then by a slight reduction in ADFI at the highest SID Lys:CP treatment of 6.49%. A similar response was observed for F/G (cubic, P < 0.001), where F/G improved when SID Lys:CP ratio was increased from 4.68 to 5.13%, followed by a worsening of F/G as the SID Lys:CP ratio increased further to 6.03%, with a slight improvement in F/G at the highest SID Lys:CP ratio of 6.49%. Increasing SID Lys:CP decreased (cubic, P ≤ 0.004) N intake per day and per kg gain, as well as reduced (linear, P < 0.001) blood urea nitrogen. In conclusion, increasing SID Lys:CP worsened F/G and decreased BUN in 163 to 214 lb pigs. Based on the local minimum determined using the cubic model, the estimated SID Lys:CP ratio to optimize F/G for pigs weighing between 163 to 214 lb is 4.98%, which is below the estimate calculated from NRC (2012).

[1] Department of Diagnostic Medicine/Pathobiology, College of Veterinary Medicine, Kansas State University.

[2] Navales, R. A., A. K. Jenkins, T. H. Kim, J. Arroyave, J. M. DeRouchey, K. N. Gaffield, J. T. Gebhardt, R. D. Goodband, M. D. Tokach, and J. C. Woodworth. 2025. Effect of standardized ileal digestible lysine to crude protein ratio on growth performance of 100 to 275 lb pigs. Kansas Agricultural Experiment Station Research Reports.

Impacts of Reducing Dietary Crude Protein through Soybean Meal in Grow-Finish Swine Rations

Sara Virdis1, Katelyn N. Gaffield, Jordan T. Gebhardt[1], Mike D. Tokach, Robert D. Goodband, Joel M. DeRouchey, Alan J. Warner[2], Carlos Villalvazo Puente[2], Chad Hastad[2], David A. Clizer[3], and Jason C. Woodworth

Summary

A total of 1,030 grow-finish pigs [PIC 800 × (Fast LW × PIC L02), initially 66.8 ± 0.58 lb] were used to determine the impact of reducing dietary crude protein (CP) on growth performance and carcass characteristics. The dietary treatments consisted of graded levels of CP (High, Medium-High, Medium-Low, and Low), accomplished through the reduction of dietary soybean meal (SBM) and inclusion of feed grade amino acids (AA). The dietary CP levels and phase feeding durations were: phase 1 from 60 to 100 lb of body weight (BW), with CP ranging from 21 to 18%; phase 2 from 100 to 175 lb, with CP ranging from 18.3 to 15.3%; phase 3 from 175 to 250 lb, with CP ranging from 16 to 13%; and phase 4 from 250 to market with CP ranging from 14.8 to 11.8%. Pen weights and feed disappearance were recorded every 14 d, and prior to each marketing event, to calculate average daily gain (ADG), average daily feed intake (ADFI), and feed efficiency (F/G). Carcass characteristics were collected for each marketing event. The reduction of CP did not affect BW. In phases 1 and 2, there were no differences among dietary treatments. However, in phase 3, the reduction in dietary CP resulted in a tendency for a quadratic effect on ADG (quadratic, P = 0.054), and tended to decrease ADFI (linear, P = 0.082). Moreover, during phase 4, reducing CP resulted in greater ADG (linear, P = 0.021) and improved feed efficiency (linear, P = 0.002). Overall, reducing dietary CP tended to improve F/G (linear, P = 0.058) but tended to worsen caloric efficiency (linear, P = 0.079). Feeding low levels of CP increased the loin depth (linear, P = 0.022), carcass yield (linear, P = 0.020) of pigs at the first marketing event and increased (linear, P = 0.033) fat depth in the second marketing event. For the overall carcass data, carcass weight (linear, P = 0.075), backfat depth (linear, P = 0.055), and carcass ADG (linear, P = 0.083) tended to increase, carcass yield increased (linear, P = 0.033), and carcass F/G improved (linear, P = 0.017) when reducing dietary CP. In conclusion, reducing dietary CP through increased feed grade AA and reduced SBM in grow-finish pig diets tended to improve F/G and increased carcass yield resulting in a tendency for increased carcass weight and improved carcass efficiency but tended to increase caloric efficiency and fat depth.

[1] Department of Diagnostic Medicine/Pathobiology, College of Veterinary Medicine, Kansas State University.
[2] New Fashion Pork, Jackson, MN.
[3] CJ America-Bio, Downers Grove, IL.

Effects of Different Standardized Ileal Digestible Lysine Programs on Grow-Finish Pig Growth Performance and Economics

Joana Magoga1, Dwight Shawk2, Jordan T. Gebhardt[1], Jason C. Woodworth, Joel M. DeRouchey, Robert D. Goodband, and Mike D. Tokach

Summary

A total of 2,160 pigs (PIC 337 × 1050; initially 68.3 ± 1.36 lb) were used to evaluate the effects of different standardized ileal digestible (SID) Lys curves and phase-feeding strategies on grow-finish pig performance and economics. Pens of pigs (27 pigs/pen) were allotted to one of four treatments with 20 replicate pens per treatment. Treatments consisted of: A) a six-phase program with 92% of the SID Lys requirement fed in phases 1 to 3 and 100% in phases 4 to 6; B) a six-phase program with 100% SID Lys fed throughout; C) a six-phase program with 86% SID Lys requirement fed in phases 1 to 3 and 94% in phases 4 to 6; and D) a four-phase program with SID Lys levels of 86%, 92%, 100%, and 108% of the requirement fed across phases. The estimated SID Lys requirements were based on the 2021 PIC mixed-sex estimates. From d 0 to 42, pigs fed the four-phase Lys program (86% of the SID Lys requirement in phase 1 and 92% in phase 2) had greater ($P < 0.05$) ADG than pigs fed 86% of the SID Lys requirement in phases 1 to 3, with intermediate performance observed for pigs fed 92% and 100% of the SID Lys requirement in phases 1 to 3. No differences were observed in ADFI among treatments. Consequently, pigs fed 92% of the Lys requirement in phases 1 to 3 and pigs fed the four-phase Lys program were heavier at d 42 than pigs fed 86% of the Lys requirement in phases 1 to 3, with pigs fed 100% intermediate ($P < 0.05$). Feed efficiency was improved ($P < 0.05$) for pigs fed either 92% or 100% of the SID Lys requirement in phases 1 to 3 compared with pigs fed 86% of the requirement in phases 1 to 3, whereas pigs fed the four-phase program were intermediate. From d 42 to 84, no differences were observed in ADG, ADFI or F/G among treatments. On d 84, pigs fed the 4-phase Lys program were heavier ($P < 0.05$) than those fed 86% of the SID Lys requirement in phases 1 to 3 followed by 94% in phases 4 to 6, and those pigs fed 100% the requirement throughout, with pigs fed 92% of the SID Lys requirement in phases 1 to 3 followed by 100% in phases 4 to 6 intermediate. Overall (d 0 to 84), pigs fed the four-phase Lys program had numerically the greatest ($P = 0.073$) ADG and pigs fed 86% of the SID Lys requirement in phases 1 to 3 followed by 94% in phases 4 to 6 having the lowest. No differences were observed in ADFI or F/G among treatments. There were no differences in mortality or total removals and mortality. Feed cost per pig and feed cost per pound of gain were reduced for pigs fed 86% of the SID Lys requirement in phases 1 to 3 followed by 94% in phases 4 to 6 compared with pigs fed 100% of the requirement throughout ($P \leq 0.013$). Nevertheless, no differences were observed in revenue per pig placed or income over feed cost. In summary, the four-phase feeding program, which increased SID Lys from 86 to 108% of the requirement estimate across phases improved growth performance and final body weight. In contrast, the reduced SID Lys program (86 to 94% of requirement) lowered feed costs but also reduced growth performance, resulting in no differences in income over feed cost among treatments.

[1] Department of Diagnostic Medicine/Pathobiology, College of Veterinary Medicine, Kansas State University.
[2] Hord Family Farms, Bucyrus, OH.

Pathology Influencing Dead-on-Arrival and Euthanized-on-Arrival Pigs at a Packing Plant During the Summer and Evaluation of Associated Transit Factors

Annika Senn,[1] Jordan T. Gebhardt,[2] Sara Virdis,[2] Josh R. Flohr, and Grace E. Houston[3]

Summary

A total of 3,176 transportation records, representing 498,281 pigs, delivered to a commercial swine processing facility (Triumph Foods, St. Joseph, MO) were evaluated in June 2026. Data compiled included transportation details such as travel distance and number of animals per load, among others. Additionally, weather data were extracted from a local National Weather Service observation station and aligned with delivery timelines. For 9 days, a subset of loads with dead-on-arrival (DOA) and euthanized-on-arrival (EOA) animals were selected and necropsies were performed on these animals. A total of 80 necropsies (28 DOA, 52 EOA) were performed, and gross pathology was recorded based on visual assessment. Reasons for euthanasia of EOA pigs included lameness (n = 34) or significant morbidity (EOA-morbid; n = 19), such as being laterally recumbent and unable to recover or demonstrating evidence of shock. Of the 28 DOA and 19 EOA-morbid animals, increased pericardial fluid (64%; 37%, DOA, EOA, respectively), cardiac petechiae (71%; 32%), lung consolidation (61%; 47%), degenerative fat and muscle changes (54%; 11%), lung edema (46%; 47%), lung adhesions (18%; 21%), bruising (18%; 16%), and chronic pericardial changes (18%; 21%) were observed. Of the 34 EOA animals euthanized for lameness, 53% had a broken bone (of pigs with broken bones, 44.4% femur, 44.4% humerus, 11.1% tibia and fibula). Transit factors associated with increased DOA included (all $P \leq 0.011$): head received, wind direction, wind speed, driveway duration, backfat, loin depth, and dew point. Transit factors associated with increased EOA included (all $P < 0.001$): head received, unload hour, unload duration, travel distance, and unload dew point. Transit factors associated with total transportation losses (TTL; sum of DOA and EOA) included (all $P \leq 0.022$): head received, wind direction, unload duration, gate to finish duration, travel distance, backfat, loin depth, and unload dew point. Based on the gross necropsy findings, all animals that were DOA/EOA-morbid had underlying heart and/or lung pathology. Of animals euthanized for lameness upon arrival, 53% had a broken bone leading to the euthanasia decision. The identified transit factors and underlying heart or lung pathology likely contribute to increased losses at the packing plant.

[1] College of Veterinary Medicine, Kansas State University, Manhattan, KS
[2] Department of Diagnostic Medicine/Pathobiology, College of Veterinary Medicine, Kansas State University, Manhattan, KS
[3] Triumph Foods LLC, St. Joseph, MO.

Effect of Enterotoxigenic *Escherichia coli* F18 Inoculum Concentration on Clinical Response Following Orogastric Challenge in Nursery Pigs

Jessica L. Smallfield, Jordan T. Gebhardt1, Mike D. Tokach, Jason C. Woodworth, Joel M. DeRouchey, Robert D. Goodband, Katelyn N. Gaffield, Raghavendra G. Amachawadi[2], Harith Salih[2], and Taghreed Mahmood[2]

Summary

A total of 45 weanling pigs (241 × 600 DNA; initially 15.4 ± 0.47 lb) were used in a 14-d study to evaluate the effect of Enterotoxigenic *Escherichia coli* (ETEC) F18 inoculum concentration on growth performance and fecal characteristics of nursery pigs. Pigs were group-housed for a 7-d acclimation period before being individually housed for inoculation (d 0 of the study). From d −7 to 14, pigs were fed a common nursery diet without pharmacological levels of Zn or Cu. Pigs were randomly allotted to one of three inoculum concentrations (109, 108, or 107 cfu/mL) in a completely randomized design with 15 replications per treatment. Each pig received 6 mL of the respective inoculum concentration followed by 6 mL of sterile phosphate-buffered saline via orogastric gavage using a 10 Fr feeding tube. The isolate used was an F18 fimbrial type with genes for heat-labile enterotoxin (LT), heat-stable toxin A (STa), heat-stable toxin B (STb), and Shiga toxin type 2e (Stx2e) as determined via PCR and was derived from a field clinical case submission. Pig weights were measured on d 0, 7, and 14 to determine ADG, ADFI, and feed efficiency, and fecal samples were collected on d 0, 3, 7, 10, and 14 to measure fecal dry matter (DM) by drying at 131°F for 48 h. All animals were euthanized on d 14 post-challenge at the conclusion of the experiment. Bodyweight at inoculation was used as a covariate for all statistical analyses. No differences were observed for growth performance during period 1 (d 0 to 7), period 2 (d 7 to 14), or overall (d 0 to 14). Growth rates were very low for d 0 to 7 for all treatment groups and improved from d 7 to 14 for the pigs remaining. A total of five pigs died or were euthanized for welfare reasons during the experiment ($P = 0.888$), with 2, 0, and 3 pigs resulting in mortality from treatments 109, 108, and 107 cfu/mL, respectively. For fecal DM, there was no evidence of a treatment × day interaction ($P = 0.387$) or treatment effect ($P = 0.146$), although a significant time effect ($P < 0.0001$) was observed. Mean fecal DM was 15.7, 11.4, 12.5, 19.3, and 15.8%, for d 0, 3, 7, 10, and 14, respectively. Averaged across all sample collection days, fecal DM was 15.8, 15.8, and 13.3% for treatments 109, 108, and 107 cfu/mL, respectively, although no significant means separation was observed. In conclusion, the ETEC F18 inoculum concentrations used in this study resulted in similar growth performance and clinical outcome.

[1] Department of Diagnostic Medicine/Pathobiology, College of Veterinary Medicine, Kansas State University.
[2] Department of Clinical Sciences, College of Veterinary Medicine, Kansas State University.

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