food animal agriculture. The current study investigated the efficacy of a dairy-origin probiotic bacterium, *Propionibacterium freudenreichii* strain N3523 (PF) against *S.* Heidelberg using *in vitro* and *in vivo* experiments. The *in vitro* experiments included motility-, multiplication-, adhesion- and invasion assays in modified motility medium, cecal contents, and avian epithelial cell lines, respectively. In addition, probiotic qualities of PF were tested by exposing it to low pH, and bile salts, and conducting hemolysis-, antibiotic susceptibility-, antimicrobial activity-, and adhesion and invasion- assays. Follow up *in vivo* experiments were conducted in 2-week, 7-week, and 12-week old commercial turkeys to determine the efficacy of PF against *S*. Heidelberg colonization. For all *in vitro* assays, the treatments were duplicated and the experiments were repeated at least 3 times. For *in vivo* studies, each treatment group had at least 12 birds, and the experiments were repeated. Data were analyzed using the PROC-MIXED procedure of SAS, with a $P<0.05$ determining statistical significance. The *in vitro* results revealed that PF was effective in reducing *S*. Heidelberg motility, multiplication, adhesion, and invasion to avian epithelial cells ($P<0.05$). PF possessed high survival rate in low pH and in the presence of bile salts. PF did not possess hemolytic activity and showed susceptibility to the common antibiotics, ensuring the safety for use in turkeys. Additionally, the cell-free extracts of PF possessed antimicrobial activity against pathogens, including *S*. Heidelberg ($P<0.05$). In the *in vivo* experiments, the reduction in the *S*. Heidelberg populations ranged from 1.0- to 2.7- $\log_{10}$ CFU/g of the cecum in different age groups ($P<0.05$). In addition, PF supplementation significantly reduced *S*. Heidelberg invasion of liver and spleen of turkeys ($P<0.05$). PF colonized in high numbers (~5.0 $\log_{10}$ CFU/g) in the cecum, indicating its high adherence potential. In conclusion, PF could be used as an effective probiotic in turkeys to prevent *S*. Heidelberg colonization and dissemination to internal organs. The research was financially supported by the Minnesota AES Project (State Special).

Key Words: Propionibacterium freudenreichii, Salmonella Heidelberg, Turkeys

351 Effects of Tylosin Administration Route on the Development of Antimicrobial Resistance in Fecal Enterococci of Finishing Swine. F. Wu*, M. D. Tokach, J. M. DeRouchey, S. S. Dritz, J. C. Woodworth, R. D. Goodband, K. Capps, S. Remfry, K. Chitakasempornkul, N. M. Bello, T. G. Nagaraja, R. G. Amachawadi, *Kansas State University, Manhattan, KS*

Antibiotics can be administered via various routes in swine production, which may influence antimicrobial resistance development. A total of 40 barrows and 40 gilts (initially 93.9 ± 3.57 kg BW) were used in a 35-d study to determine the effects of tylosin administration route on growth performance and antimicrobial resistance in fecal enterococcus isolates. Pigs (1 pig/pen, 20 pigs/treatment) were blocked by initial BW and gender. Within blocks, combinations of 2 pens (1 barrow pen and 1 gilt pen) were assigned randomly to 1 of 4 treatments. The antibiotic treatments followed US label directions and were: 1) no antibiotic (CON), 2) 110 mg tylosin per kg feed for 21 d (FEED), 3) 8.82 mg tylosin per kg BW through intramuscular injection twice daily for the first 3 d of each wk during the 3-wk treatment period (IM), and 4) 66 mg tylosin per liter of drinking water for the first 3 d of each wk during treatment period (WATER). Antibiotics were administered during d 0 to 21 and all pigs were then fed a common diet with no antibiotic treatment from d 21 to 35. Among the medicated pigs, total tylosin dose administrated was 18.0g via IM, 8.6g in FEED, and 3.7g with WATER. Fecal samples were collected on d 0, 21, and 35. Antimicrobial susceptibility was determined according to minimal inhibitory concentration breakpoints. No evidence for route×gender interactions ($P>0.55$) were observed for growth performance. From d 0 to 21, pigs receiving CON and FEED had greater ($P<0.05$) ADG than those receiving IM, with the WATER group intermediate (1.26, 1.26, 1.15, 1.22 kg/d, respectively). There was no evidence for different ADFI among treatments. Pigs receiving IM (0.324) or WATER (0.322) had poorer ($P<0.05$) G:F than CON (0.347), but were not different from pigs receiving FEED (0.339). No evidence for route×day interactions ($P>0.23$) were observed for enterococci resistance to any antibiotic. Overall, enterococcal isolates collected from pigs receiving FEED or IM were more resistant ($P<0.05$) to erythromycin and tylosin than CON and WATER groups. Resistance prevalence to these 2 antibiotics was greater on d 21 and 35 than d 0. In summary, tylosin injection decreased ADG and G:F of finishing pigs, likely due to the stress reaction to handling and injection. Tylosin administration through injection and feed resulted in greater probability of enterococcal resistance to erythromycin and tylosin compared with in-water treatment, which is likely a combined effect of administration route and dosage.

Key Words: administration route, antimicrobial resistance, fecal enterococci

352 Modeling Dietary Net Energy for Maximum Profitability in Growing-Finishing Pigs. J. A. Soto*[,1], M. D. Tokach[1], S. S. Dritz[1], M. A. D. Goncalves[2], J. C. Woodworth[1],

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Knowledge of energy use by the pig is essential to predict, optimize, and formulate diets to achieve expected performance. Taking into consideration the productive and financial implications of the energy density of the diet, the objective of this project was to develop a tool to estimate the dietary NE concentration that yields maximum profitability for growing-finishing pigs. A Microsoft Excel®-based model was developed to contrast dietary NE currently utilized by the user with recommended concentrations intended to maximize profitability in user-defined production and economic scenarios. The model is divided into 3 sections: 1) model inputs (including economics, production, and dietary criteria), 2) model calculations and optimization (including growth performance and carcass yield predictions, and profitability indicators), and 3) model outputs (including recommended dietary NE concentrations and profitability indicators). To calculate pig performance, the model uses prediction equations for ADG. Where ADG, g = 0.1135 × NE, kcal/kg + 8.8142 × Avg BW, kg - 0.05068 × (Avg BW, kg)^2 + 275.99, when Lys or other amino acids are not limiting. To calculate G:F, the assumption is that G:F has a linear relationship with NE in the diet. Therefore, a 1% change in NE will result in a 1% change in G:F. The model also uses the NDF content of the diet to estimate the effect of the diet on dressing percentage, where carcass yield, % = 0.03492 × WP, d – 0.05092 × NDF1, % – 0.06897 × NDF2, % – 0.00289 × (NDF2, % × WP, d) + 76.0769, where WP is the withdrawal period and NDF1 and NDF2 are the NDF levels in the dietary phase prior to the final phase and in the final phase before marketing, respectively. The model predicts responses for an average pig without population variance included. For profitability calculations, a non-linear mathematical programming model was designed to select the optimum values of dietary NE that yield the maximum profitability. In this model, the objective function of income over total cost on a live- or carcass-basis is maximized by selecting the optimal value of NE in each dietary phase. In conclusion, the model herein can be used to predict the value of dietary NE that yields maximum profitability for growing-finishing pigs.

Key Words: net energy, Growing-finishing pigs, linear programming

353 Dietary Protein Levels Affect Neonatal Pig Growth and Mesenchymal Stem Cell Behavior.

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Growth rate is highest during neonatal development and exerts lifelong effects on animal performance. Despite this, our knowledge of the nutritional requirements needed to support this rapid growth is limited. Our previous work has demonstrated that alterations in the activity and differentiation potential of mesenchymal stem cells (MSC) can dramatically impact bone growth and development. With increasing interest in and evidence of cross-talk between muscle and bone, we examined the impact of dietary protein levels on the growth of neonatal pigs and the activity of their MSC. Thirty 1-d-old (24 ± 6 h) piglets were individually housed and fed with milk replacers that were 25% deficient (D), adequate (A), or 25%in excess (E) of protein requirements based on sow milk composition and an extrapolation of the NRC requirements for older pigs. The starting weights of the pigs in each group were 1.47 ± 0.1 kg for the D and 1.46 ± 0.1 kg for the A and E groups. Body weight and feed intake were recorded daily for the 17d study. Blood was collected on d11 and d17 for serum urea nitrogen (SUN) determination. Humeri were collected for the isolation of MSC analysis and radial/ulna bones were collected for physical measurement and bone mineral determination. Final body weight and ADG were significantly higher in the E than the D group (5.60 ± 0.27kg vs 4.75 ± 0.27kg and 0.27 ± 0.01kg/d vs 0.21 ± 0.01kg/d). This increased growth rate, coupled with equal feed intake across treatment groups, led to improved G:F in the E than the D group ($P<0.05$). SUN level increased with increasing dietary protein levels at both d11 and d17 ($P<0.05$). Radial/ulna bone volume was significantly greater in the E and A groups than in the D group characterized by increased radius cross sectional area (E: 39.94 ± 1.87mm^2; A: 39.21 ± 1.97mm^2, D: 33.21 ± 1.87mm^2). The E group had significantly higher bone weight (19.05 ± 0.76g vs 15.82 ± 0.75g) but lower bone ash ratio than D group (%) (35.6 ± 0.4 vs 37.9 ± 0.4). No significant difference for dry bone and bone ash weight was found among groups. In vivo MSC proliferation rate (%), as determined by BrdU labelling, was significantly higher in the E than the D group (19.9 ± 2.9 vs 11.4 ± 2.9). These findings suggested that dietary protein levels in excess of what is currently considered required during the neonatal period allows for improved growth and feed efficiency. Additionally, early dietary protein deficiency alters neonatal bone development, potentially via alterations in MSC activity.

Key Words: Protein levels, Pig growth, Mesenchymal stem cell