

Nonruminant Nutrition: Feed Additives

754 Effect of different probiotics on diarrhea frequency and body weight of weaned piglets challenged with *Salmonella typhimurium*. L. J. Parazzi,* E. R. Afonso, S. M. M. K. Martins, T. A. Santo, A. F. C. Andrade, J. Diniz-Magalhães, and A. S. Moretti, *USP/FMVZ, Pirassununga, SP, Brazil*.

The aim of study was to test the effect of different probiotics fed to piglets on diarrhea frequency and body weight. The probiotic A (PA) mixture was composed of *B. subtilis*, *B. bifidum*, *E. faecium*, *L. acidophilus*, *L. casei*, and *L. lactis* and probiotic B (PB) contained *B. subtilis* and *B. toyoi*. A total of 160 crossbred piglets were weaned at 23 d of age, blocked by initial weight, equalized for sex, and distributed to 8 treatments: PA44 (4kg/ton) and PB44 (2kg/ton) fed through 44 d of age; PA65 (4kg/ton to 44 d and 2kg/ton to 65 d) and PB65 (2kg/ton to 44 d and 1kg/ton to 65 d) fed through 65 d of age; PA138 (4kg/ton to 44 d and 2kg/ton to 138 d) and PB138 (2kg/ton to 44 d and 1kg/ton to 138 d) fed through 138 d of age; control (C) without additives, and Antimicrobial (Atb), with antibiotic growth promoter. At 51 d of age, piglets received an oral dose of 1×10^5 UFC/pig of *S. typhimurium* (LSS-SR41). Feces from each experimental unit (4 pigs/pen) were visually examined every day (23 to 79d) to determine the diarrhea frequency using a subjective score on scale ranging from 1 to 3, where 1 = normal; 2 = soft feces; 3 = liquid feces. Piglets receiving Atb showed higher occurrence of normal feces compared with PA ($P = 0.0485$) and similar compared with PB during 23 to 79 d, independent of the administration period both PA and PB. Piglets fed PB138 demonstrated higher frequency of normal feces (32.75% vs 19.56%, respectively) and lower liquid feces (26.54% vs 35.62%, respectively) in relation to PA138. During 23 to 65 d of age, piglets fed Atb showed a higher body weight ($P < 0.05$) compared both PA and PB (25.99, 21.74 and 21.91 kg, respectively), but at slaughter (138 d) body weights were similar between all treatments ($P > 0.05$). In conclusion, the probiotic PA was not effective in reducing the incidence of diarrhea compared with PB and Atb, but the final body weights were similar, suggesting medium- and long-term actions of these probiotics on intestinal health.

Key Words: diarrhea, probiotics, *S. typhimurium*

755 Effect of mannan oligosaccharides on performance of weanling piglets. F. C. Horta, L. J. Parazzi,* S. M. M. K. Martins, O. H. O. Eckhardt, T. A. D. Santo, A. F. C. Andrade, J. Diniz-Magalhães, and A. S. Moretti, *USP/FMVZ, Pirassununga, SP, Brazil*.

The mannan oligosaccharides (MOS) have been used as prebiotics in the diets of pregnant and lactating gilts and weaned piglets. The aim of the study was to evaluate the effect of MOS in the diet on gestation and lactation of gilts and piglets during the weaning period on growth performance in the nursery. In a 2×2 factorial arrangement, 17 gilts and 140 weaned piglets (23 d of age) were used. There were 8 replicate pens (4 pigs/pen) per treatment, except CC and MM with 9 and 10, respectively. The compositions of diets for gilts and piglets were based on corn and soybean meal met NRC recommendations (1998). The groups consisted of gilts and piglets either fed with MOS (BioMOS, Alltech, 28% of the glucomannoprotein from *Saccharomyces cerevisiae*) or without it. The treatments were: MM (feeding MOS to gilts and piglets), MC (feeding MOS only to gilts), CM (feeding MOS only to piglets) and CC (control diets to gilts and piglets). The gilts received MOS at late gestation (81 ± 1.36 d) and lactation (0.1% MOS) and the piglets received MOS on the following schedule: 0.4% of the diet beginning on the last week of lactation to 37 d of age, 0.2% from 38 to 51 d of age, and 0.1% from 52 to 65 d of age. At 35 d of age, piglets were challenged orally ($1 \times$

10^8 cfu/piglets) of *Salmonella typhimurium*. The weaning weight by the 5th week was higher ($P < 0.05$) in MM and MC treatments. Feed intake during first week post-weaning was higher ($P = 0.0449$) in MM and MC than CM and CC. The same result was observed for weight gain of piglets during the 2nd week ($P = 0.002$), but the CM and CC treatments showed a lower ($P = 0.0103$) G:F compared with MM and MC. In the 6th week, MM and MC treatments exhibited a higher feed intake ($P = 0.0007$), however, with no difference in the body weight of piglets. MM and MC piglets maintained highest body weight despite the challenge employed. In conclusion, supplementation with MOS in the diets of gilts increased the body weights of piglets by 5th week, independent the piglet MOS supplementation.

Key Words: mannan oligosaccharides, piglets, *S. typhimurium*

756 Multi-NSP enzymes improved growth performance and gut health in nursery pigs fed corn or rye and barley diets. J. Zhao,* F. Yan, D. L. Lichtenstein, A. Lawhorn, and M. Vazquez-Anon, *Novus International Inc., St Charles, MO*.

This study was conducted to investigate the benefits of an NSP enzyme blend in pigs fed either corn or rye and barley diets. A total of 128 nursery pigs (34 d of age, 9.95 ± 0.28 kg) were randomly assigned to 4 treatments with 8 replicates per treatment and 4 pigs per pen. The trial was a 2×2 factorial arrangement with 2 diet types (corn vs. rye and barley) with and without NSP enzyme for 3 phases (d 0–20, d 21–32, and d 33–55). Rye and barley were added at 30% and 15%, respectively. The enzyme (combination of Cibenza CSM and DE200, Novus International Inc., St. Charles, MO) is a blend of endo-xylanase, β -glucanase, α -galactosidase, and β -mannanase. Feed was withdrawn from all pigs from d 21–23 and d 28–30 to create a minor gut health challenge. Gain:feed was improved with enzyme supplementation in phase I and phase III in both corn (7 and 9%, respectively) and rye and barley diets (9 and 13%, respectively, $P < 0.05$). The presence of enzyme tended to improve daily weight gain (443 vs. 480 g, $P = 0.08$) and body weight in phase I (18.8 vs. 19.6 kg, $P = 0.08$) regardless of diet type. Daily feed intake was significantly decreased with enzyme supplementation in phase III (2.353kg vs. 2.209 kg, $P = 0.03$), perhaps due to improved energy utilization. No differences were observed on cecum viscosity, *E. coli*, *Clostridium*, and coliform counts among treatments ($P > 0.10$). Total aerobic counts were significantly reduced with enzyme supplementation at all 3 time points ($P < 0.02$). On d 55, cecum lactic acid bacteria counts were increased ($P < 0.01$) while pH was decreased (6.21 vs. 5.59, $P < 0.01$) with enzyme supplementation. Decreased intestinal pH is beneficial for controlling pathogenic bacteria in general. No significant effects of diet type or interaction of diet type and enzyme supplementation were observed on either growth performance or gut health measurements. In conclusion, enzyme improved feed utilization and weight gain in both corn and rye and barley diet in pigs. The benefits are partially associated with improved gut health.

Key Words: NSP, enzyme, swine

757 Effect of increasing concentrations of a novel β -glucanase to a constant β -mannanase in corn-soybean meal-corn distillers dried grains with solubles (DDGS) diets on grower pig performance. Z. Rambo¹, J. Ferrel², D. Anderson², D. Kelly¹, and B. Richert¹, ¹Purdue University, West Lafayette, IN, ²ChemGen, Gaithersburg, MD.

Two-hundred 52 pigs (initial BW = $26.0 \text{ kg} \pm 0.45$) were used to evaluate the effect of adding a β -glucanase (ENZ1) to a β -mannanase (ENZ2)

enzyme, titrated at 5 concentrations, in a corn-soybean meal-DDGS diet on pig growth and feed efficiency during the grower period. Pigs were allocated in a randomized complete block design of mixed sex pens, stratified by sex, litter and initial BW to 6 treatments with 7 pens/treatment. Dietary treatments were: T1-Negative Control (no enzymes), treatments 2–6 had a constant level of Enz2 at 0.16 MU/kg plus increasing levels of Enz1; T2 = 0 MU/kg, T3 = 0.044 MU/kg, T4 = 0.088 MU/kg, T5 = 0.132 MU/kg, and T6 = 0.176 MU/kg of Enz1. Pigs were fed 2 dietary phases (25 and 30% DDGS, respectively), each 3 weeks in duration. Individual BW and pen feed disappearance were recorded weekly. Phase 1 ADG was greater for T5 compared with T1 ($P < 0.05$) with all other treatments being intermediate (743, 768, 780, 768, 782, 772 g/d; T1-T6, respectively). Phase 1 G:F tended to linearly ($P < 0.07$) increase with increasing levels of Enz1 (0.449, 0.449, 0.456, 0.465, 0.473, 0.465, respectively). During phase 2 there were no differences in ADG among treatments; however, G:F linearly ($P < 0.02$) improved with increasing levels of Enz1 (0.372, 0.367, 0.378, 0.371, 0.382, 0.385, respectively). Overall ADG was greater for T3, T5, T6, compared with T1 ($P < 0.05$) with T2 and T4 being intermediate (788, 801, 825, 810, 817, 818 g/d; respectively). Overall G:F linearly ($P < 0.01$) improved with increasing levels of Enz1 (0.400, 0.397, 0.407, 0.405, 0.416, 0.414, respectively). Final BW was greater for T3 compared with T1 with all other treatments being intermediate (59.5, 60.2, 61.2, 60.6, 60.8, 60.8 kg, respectively). Increasing levels of β -glucanase (Enz1) linearly improved feed efficiency (4.8%) during the grower period and numerically improved ADG and final BW with corn-soybean meal diets containing up to 30% DDGS.

Key Words: swine, β -glucanase, β -mannanase

758 Evaluating nutritive value of pepper *Capsicum annuum* and garlic *Allium sativum* on performance, egg trait and serum parameters of old layers. F. A. Aderemi,* O. M. Alabi, and O. M. Ayoola, *Bowen University, Iwo State, Nigeria.*

This study was conducted to investigate the effects of garlic powder and dried pepper on the performance, egg traits, egg cholesterol and serum parameters of laying chickens. A 10-wk study was carried out using 90 ISA brown layers that have laid eggs for 2 years. The diets were formulated such that diet I with 0% pepper and garlic served as the control, while diets II and III had 4g/kg of dried pepper and powdered garlic, respectively. The layers were divided into 3 groups fed on these diets and replicated thrice. Data were analyzed by ANOVA using a completely randomized design. The results showed that there were no differences ($P > 0.05$) among the dietary treatments in feed consumption and feed efficiency; layers receiving garlic powder had better numerical values as compared with pepper and control. There were improvements ($P < 0.05$) in egg albumen index and Haugh unit of garlic-fed layers. There was also a reduction ($P < 0.05$) in egg yolk cholesterol concentration of layers fed the garlic-supplemented diet compared with the pepper and control diets. Serum total protein of garlic-fed layers increased ($P < 0.05$), while blood glucose and cholesterol levels decreased ($P < 0.05$). We concluded that garlic improved performance characteristics and may increase egg shelf life as indicated by egg quality measurements.

Key Words: garlic powder, dried pepper, layers

759 Defatted algae biomass may replace one-third of soybean meal in diets for laying hens. X. J. Leng, K. N. Hsu, R. E. Austic, and X. L. Lei,* *Cornell University, Ithaca, NY.*

Although soybean meal is a commonly-used source of feed protein for laying hens and other food-producing animals, it is very expensive and limited in supply. Microalgae have recently been explored as a new

exciting source of biofuel, and the residual biomass contains a good amount of protein and other nutrients. The present study was conducted to determine whether defatted algal biomass from biofuel production (Cellana, Kailua-Kona, HI) could replace a portion of soybean meal or a combination of corn and soybean meal in diets for laying hens. A total of 100 ISA Babcock White Leghorn laying hens (47 weeks old, *Gallus gallus domesticus*) were randomly assigned to 4 dietary treatments. There were 5 replicates for each treatment and each replicate consisted of 5 individually caged hens. The 4 experimental diets included a corn-soybean meal basal diet (BD), the BD with 7.5% defatted algae and the 5 most limiting amino acids substituting for 7.5% soybean meal, and the BD with 7.5% or 15% defatted algae substituting for soybean meal and corn. During the 8-week experiment, hens fed 15%, but not 7.5% defatted algae had lower ($P < 0.05$) egg production rate (-12%) and daily feed intake (-9 g) than those fed the BD. There was no significant difference in egg weight (58–61 g), shell strength (33–35 N), and shell specific gravity (1.08) or activities of plasma alanine aminotransferase (24–33 U/L) and alkaline phosphatase (112–155 U/mL) among the 4 dietary treatment groups at wk 4 and/or wk 8. The inclusion of defatted algae tended to decrease the lightness (L value) and yellowness (b value) of the egg yolk color ($P < 0.05$), but increased the redness (a value; $P < 0.05$). In conclusion, it was feasible to substitute 7.5% defatted algae for soybean meal or for a combination of corn and soybean meal in the diets of laying hens without adverse effects on their health or egg production. Supported in part by a USDA/DOE Biomass R&D Initiative grant.

Key Words: algae, biofuel, laying hens

760 Effects of various replacements of corn and soy by defatted microalgal meal on growth performance and biochemical status of weanling pigs. K. K. Lum,* K. R. Roneker, and X. G. Lei, *Cornell University, Ithaca, NY.*

Marine microalgae biomass derived from biofuel production has great potential as a nutrient-rich alternative feed protein or energy source. Our objective was to evaluate effects of partial replacements of corn and soybean meal by defatted algal meal in diets for young pigs on their overall growth performance and biochemical status. Weanling pigs (BW = 13.4 \pm 1.6 kg; n = 8/treatment) were individually housed and fed for 6 wk with 1 of 4 diets: corn-soybean meal basal diet (BD), BD with 7.5% defatted algal meal (provided by Cellana, Kailua-Kona, HI) in replacing 7.5% soybean meal, and BD with 7.5 and 15% defatted algal meal in replacing 7.5 and 15% corn and soybean meal in combination, respectively. Data were analyzed using one-way ANOVA as complete random design with or without time-repeated measurements. Compared with those fed the BD, pigs fed 15% defatted algal meal had 9% lower final BW ($P < 0.05$) and 12% lower overall ADG ($P < 0.05$). The substitution of 7.5% defatted microalgal meal for the same amount of soybean meal also resulted in 12% lower overall ADG ($P < 0.05$) than the control. However, ADFI, gain/feed efficiency, and the percent body lean yield predicted by ultrasound scans at wk 6 were not significantly affected by the dietary treatments. Likewise, there were no treatment differences in the biweekly analyses of plasma biochemical indicators including urea nitrogen concentration, alanine aminotransferase, and alkaline phosphatase activities, and total triglycerides, cholesterol, and nonesterified fatty acid concentrations. In conclusion, weanling pigs manifested comparable growth performance and plasma biochemical status in responses to the replacement of 7.5% soybean meal and corn by defatted microalgal biomass, but failed to tolerate a higher level (15%) of such replacement, or the sole replacement of 7.5% soybean meal. Supported in part by a USDA/DOE Biomass R&D Initiative grant.

Key Words: microalgae, pigs, nutrition

761 Effects of a blend of essential oils on post-weaning growth performance of piglets. A. Aufy^{*1}, T. Steiner¹, and Y. Jung², ¹*Biomin Holding GmbH, Herzogenburg, Austria*, ²*Jung P&C Institute, Yeongdoek-Dong, Giheung-Gu, Yongin-City, Gyeonggi-Do, Korea*.

As a consequence of the ban on antibiotic growth promoters (AGPs) in several countries, piglets have been exposed to different challenges that have resulted in a notable deterioration in productive performance. The aim of this study was to investigate the effects of a phytogetic feed additive (PFA) on piglet performance and to evaluate it as an alternative to AGPs. A total of 360 weanling crossbred (Duroc × Yorkshire × Landrace) pigs with an initial body weight of 6.7 kg, weaned at 23 d of age, were used in 28-d growth feeding experiment. Pigs were randomly allocated to 1 of 3 experimental treatments. Each treatment had 30 pigs per pen and 4 replications (pens). Treatments were negative control (commercial diet based on corn and soybean meal), positive control (commercial basal diet + 100 mg/kg apramycin/ton), and PFA (commercial diet + 125 mg/kg Biomin P.E.P. 125). Two-phase feeding programs were implemented with phase 1 diet fed from 0 to 14 d and phase 2 diet fed from 14 to 28 d post-weaning. All experimental diets were fed in crumbled feed. The data set was analyzed using the GLM procedure of SAS (1998) with pen as experimental unit by adjusting initial body weight. Through the experimental period from d 1 to d 28 post-weaning, performance parameters including body weight, body weight gain, feed intake, feed conversion ratio and mortality were recorded. The results obtained revealed that piglets treated with PFA had 1 to 7% higher body weight than the negative control group and the AGP group respectively. Piglets treated with the PFA showed significantly higher ($P < 0.05$) average daily gain than the AGP group while the difference to the negative control group was numerically higher. At d 28, there were no significant differences in feed intake between the groups. Dietary supplementation with the PFA attained significantly lower ($P < 0.05$) feed conversion ratio values than the AGP supplemented group and insignificant values compared with the negative control group. No mortality was observed in the PFA group while dietary supplementation with AGP insignificantly ($P > 0.05$) reduced mortality by about 32%. The efficacy of any feed additive is judged by its potential to improve mainly feed utilization (feed conversion ratio) and other physiological parameters. The present study showed performance promoting effects in piglets fed the PFA, indicating its potential use as growth enhancer and as successful alternative to AGP piglet rations.

Key Words: phytoгенics, growth performance, piglets

762 Effects of a dietary antioxidant blend on growth and plasma markers of oxidative status in pigs fed an oxidative stress diet. T. Lu^{*1}, A. F. Harper¹, J. Zhao², R. A. Dalloul¹, and M. J. Estienne¹, ¹*Virginia Polytechnic Institute and State University, Blacksburg*, ²*Novus International Inc., St. Charles, MO*.

Crossbred barrows ($n = 100$, 10.9 kg BW, 36 ± 2 d of age) were used to assess inclusion of a commercial antioxidant (AOX; Agrado Plus, Novus International, St. Charles, MO) to diets formulated to increase oxidative stress. There were 5 pens of 4 pigs each in 5 treatments that included: 1) a negative control (NC) oxidative stress diet containing oxidized soy oil (5%) and a source of polyunsaturated fatty acids (PUFA, 10%) with no added vitamin E (VE) and no AOX; 2) the NC diet with 11 IU/kg of added VE; 3) the NC diet with AOX providing a proprietary antioxidant blend of ethoxyquin and propyl gallate; 4) the NC diet with AOX and VE; and 5) a standard control diet (SC) with no oxidized soy oil or PUFA source. Growth was assessed and plasma collected at defined time points throughout the 118 d study. No treatment effects were observed

in performance by d 25 ($P > 0.33$), but at d 82 BW for pigs fed the NC, VE, AOX, AOX+VE and SC diets were 48.4, 69.5, 82.3, 81.7 and 85.3 kg respectively (NC pigs lower than all others, VE pigs lower than AOX, AOX+VE and SC, $P < 0.05$). At d 82, pigs fed the NC diet were switched to the SC diet due to very poor animal condition resulting in some recovery such that by d 118, BW for the respective treatments were 83.3, 92.9, 127.3, 130.6 and 135.1 kg, for NC/SC, VE, AOX, AOX + VE, and SC, diets respectively (AOX, AOX+VE and SC pigs greater than NC/SC and VE pigs, $P < 0.05$). Plasma concentrations of thiobarbituric acid reactive substances (TBARS) and carbonyl were consistent with growth data, being elevated ($P < 0.05$) in the NC compared with the SC pigs at d 55 but corrected to a level not different from the SC pigs at d 118. At d 118, TBARS ($\mu\text{M}/\text{mL}$) was 2.76, 10.56, 4.21, 4.10 and 2.33 and carbonyl (nmol/mL) was 25.94, 71.53, 24.21, 21.31 and 19.24 for the NC/SC, VE, AOX, AOX+VE and SC fed pigs, respectively, with both markers elevated in the VE pigs compared with all other treatments ($P < 0.05$). In the oxidative stress model used in this study, dietary addition of AOX or AOX plus VE was effective in improving growth and plasma markers of oxidative stress, but VE was not.

Key Words: pigs, oxidative stress, antioxidant

763 Effects of eubiotics (VevoVital, Crina Piglets, Cylactin ME10) supplementation on growth performance, nutrient digestibility, fecal noxious gas emission, and fecal microbial shedding in weanling pigs. Z. F. Zhang^{*1}, S. M. Hong¹, A. V. Rolando², D. H. Yoo³, and I. H. Kim¹, ¹*Department of Animal Resource & Science, Dankook University, Cheonan, Choongnam, South Korea*, ²*DSM Nutritional Products Philippines Inc., Bonifacio Global City, Taguig, Philippines*, ³*All The Best Ltd., Seoul, South Korea*.

A total of 150 weanling pigs [(Landrace × Yorkshire) × Duroc, BW = 8.86 ± 0.43 kg] were used in a 42-d trial to evaluate the effects of eubiotics on growth performance, apparent total tract digestibility (ATTD), fecal microbial shedding, and fecal noxious gas emission. Pigs were randomly distributed into 1 of 5 dietary treatments on the basis of BW and litter. Each treatment had 6 replicate pens with 5 pigs per pen. Dietary treatments were as follows: T1, basal diet; T2, T1 + 0.5% VevoVital + 0.01% Crina Piglets; T3, T1 + 0.5% VevoVital + 0.007% Cylactin ME10; T4, T1 + 0.3% VevoVital + 0.01% Crina Piglets; T5, T1 + 0.3% VevoVital + 0.007% Cylactin ME10. VevoVital is an ultra-pure grade of benzoic acid, Crina Piglets contains around 10% essential oils (thymol, eugenol, and piperine), and Cylactin ME10 contains 1.0×10^{10} cfu/g of *Enterococcus faecium* NCIMB 10415. During 8–21 d, ADG and G/f in T2 and T3 treatments were improved ($P < 0.05$) compared with T1 and T5 treatments. Overall, pigs fed the T2 diet had greater ($P < 0.05$) ADG and G/f than those fed the T1 diet. Pigs fed the T2 diet significantly increased ($P < 0.05$) the ATTD of DM compared with those fed the T1 diet at d 21, while the ATTD of N in T2, T3, T4 treatments was increased ($P < 0.05$) compared with T1 treatment. The fecal *Lactobacillus* counts were increased ($P < 0.05$) by T2 treatment compared with other treatments, whereas the fecal *E. coli* population was decreased ($P < 0.05$) in T2 and T3 treatments compared with T1, T4, and T5 treatments. All the diets supplemented with eubiotics decreased ($P < 0.05$) the fecal NH_3 , total mercaptans, H_2S emission compared with T1 treatment. Results indicated that 0.5% VevoVital + 0.01% Crina Piglets could improve the growth performance, increase the fecal *Lactobacillus* population, decrease *E. coli* counts, as well as reduce fecal noxious gas emission in weanling pigs.

Key Words: eubiotics, noxious gas emission, weanling pigs