

Nonruminant Nutrition: Feed Additives

W327 Evaluation of coated and powder sodium butyrate in diets for broilers reared with reused litter during a commercial production cycle. J. Hernandez*¹, G. Afanador¹, C. Ariza-Nieto², and Y. Avellaneda^{2,1}, ¹Universidad Nacional de Colombia, Bogota Colombia, ²Corpoica, Mosquera Colombia.

Short-chain fatty acids have been widely used as feed additives, but data on the use of sodium butyrate in broilers are lacking. This study was carried out to evaluate the use of powder (99%) and coated sodium butyrate (30%) and its effects on the performance of broilers reared with reused litter during a commercial production cycle of 41 d. 720 one-day-old Avian Cobb male chicks were fed with isocaloric and isoproteic commercial type diets: starter phase (1–20 d) and finisher phase (20–41 d). Broilers were located on reused litters and randomly assigned to 1 of the 4 dietary treatment groups: (1) Control diet without supplementation (C); (2) zinc bacitracin (15%) diet 500 g/ton (CP); (3) sodium butyrate: free 98% (FB); and (4) coated 30% (CB) at a dosage of 500 g/ton in both diets (FB, CB). Data were analyzed as a completely randomized design with 6 replicates (30 birds/replicate) using GLM procedures of SAS software package. Tukey method was used to compare means ($P < 0.05$). Each replicate of birds was weighted weekly and feed residuals were used to calculate daily feed intake and feed conversion. Results showed a positive effect ($P < 0.05$) of FB and CB supplementation on productive performance compared with C group and similar ($P > 0.05$) results with CP. FB group presented the highest weight gain/day ($51.6 \text{ g} \pm 1.76$) compared with group C ($48.1 \text{ g} \pm 2.36$) ($P < 0.05$), but similar to CB group ($50.5 \text{ g} \pm 1.96$) and CP ($49.4 \text{ g} \pm 1.75$). Feed conversion showed a better result in CB (1.65 ± 0.040) and CP (1.62 ± 0.034) groups compared with C (1.76 ± 0.090) group, while FB (1.66 ± 0.026) group did not differ to all the groups ($P > 0.05$). Despite the fact that butyrate groups received different concentrations of sodium butyrate per kg feed, CB was no different to FB in the commercial performance of broilers, but sodium butyrate can be used as an alternative additive to antibiotic growth promoters.

Key Words: sodium butyrate, performance, reused litter

W328 Effect of oregano essential oils (*Lippia origanoides* Kunth) on lipid peroxidation in eggs enriched with n-3 fatty acids during storage. R. E. Ortiz*^{1,2}, G. Afanador¹, Y. Avellaneda^{1,2}, D. Vasquez², and C. Ariza-Nieto², ¹Universidad Nacional de Colombia, Bogotá, Colombia, ²Corpoica, Bogotá, Colombia.

Higher PUFA content in eggs provides a functional food, but it leads to greater susceptibility to lipid peroxidation. A natural way to increase the intrinsic antioxidant concentration is through dietary supplementation with natural antioxidants, such as oregano essential oils (OEO). There is an inverse relationship between malondialdehyde (MDA), an indicator of lipid peroxidation, and dietary antioxidant level in poultry products. A feeding study was carried out to evaluate the effects of OEO native to Colombia on oxidative stability of enriched eggs during storage. A total of one hundred eighty 48-wk-old Babcock Brown laying hens were randomly assigned to 1 of the 5 treatments: (1) Control (CONT) without supplementation; (2) vitamin E 200 g/ton (VITE); (3) OEO 100 g/ton (O100); (4) OEO 150 g/ton (O150); (5) OEO 200 g/ton (O200). Hens were individually placed in 30 cages during 8 weeks. At the end of the period, 8 freshly collected eggs from each replicate, totaling 48 eggs from each treatment were refrigerated

at 4°C and analyzed for MDA levels in yolk at 0, 15, 30 and 60 d of storage. Data were analyzed as a completely randomized design with a factorial arrangement of treatments (5×4). Tukey method was used to compare means ($P < 0.05$). Results showed that the extent of lipid oxidation, as measured by MDA formation differed ($P < 0.0001$) between dietary treatments and storage time with no interaction ($P > 0.05$). During storage significant changes occurred in egg yolk MDA value ($P < 0.001$). Fresh eggs showed 36.1 mg/g of MDA, while in eggs stored at 4°C during 60 d the MDA value increased in 32% (47.9 mg/g). The control group exhibited the higher MDA values (48.4 mg/g) comparable ($P > 0.05$) to O100 (45.4 mg/g), but different ($P < 0.0001$) than O150, VITE, and O200 (39.9, 38.4, 36.2 mg/g, respectively). There was an inverse relationship between OEO in the diet (ppm) and MDA concentration in the egg yolk ($Y = 60.69 - 0.0839 \text{ OEO}$, $R^2: 0.74$, $P < 0.0001$). It can be concluded that there is a clear oxidative stability effect of OEO supplementation in n-3 fatty acids enriched eggs during storage.

Key Words: oregano essential oil, enriched egg, yolk stability

W329 Evaluation of Optifeed Poultry in the diet of female broiler chickens. V. Noiro*¹, M. Champagnac, P. Etienne, and D. Éclache, Laboratoires Phodé, Terssac, France.

The objective of this trial was to evaluate the effect of Optifeed Poultry (OP, Laboratoires Phodé, France) based on plant extracts and designed to stimulate animal voluntary feed intake. The trial was conducted in the experimental aviary Farm School of State University of Londrina (Brazil). Four hundred and forty one-day-old Cobb female broiler chickens were divided following a completely randomized design in 5 homogeneous groups of 4 replicate pens. Each pen contained 22 birds. They were slaughtered at 48 d. The birds were given pre-starter feed for 1–7 d (22% CP, 3000 kcal/kg ME), starter for 8–21 d (20% CP, 3100 kcal/kg ME), grower for 22–42 d (19% CP, 3190 kcal/kg ME) and finisher for 43–48 d (17.5% CP, 3210 kcal/kg ME). The 5 treatments consisted in providing OP (500g/t) according to different programs: for treatment 1 only from 1 to 7 d, for treatment 2 only from 1 to 21 d, for treatment 3 during the whole experimental period, for treatment 4 OP from 1 to 7 d, no OP from 8 to 41 d and OP from 42 to 48 d, and for treatment 5 (control) no OP. The chickens were weighed weekly. Feed intake and feed conversion were evaluated for each pen and each group at weighing time. Dead birds were recorded daily. Results were submitted to ANOVA followed by Tukey test, except viability that was analyzed using chi-squared test. Feed intake between 1 and 42 d was improved with treatment 3 (4.795 kg/bird) compared with the control group (4.529 kg/bird) and compared with the other treatments ($P < 0.05$). Treatment 3 increased feed conversion measured between 1 and 21 d, 1 and 42 d, and 1 and 48 d compared with control ($P < 0.05$). OP increased live weights at 7 d with treatments 1 (196 g), 2 (196 g), 3 (200 g) and 4 (202 g) compared with control group (188 g, $P < 0.05$), without any effect on feed conversion between 1 and 7 d ($P > 0.05$). Weights at 21 d were improved only for treatment 4 (0.903 kg vs. 0.854 kg for control, $P < 0.05$). Weight at 48 d and viability were not modified by treatments ($P > 0.05$). In this trial, OP allowed to improve performances of female broiler chicken during the first week.

Key Words: female broiler chicken, feed intake stimulation, plant extract

W330 Effect of a blend of plant extracts with controlled release on the performances of heat stressed broiler. V. Noirot*, M. Champagnac, P. Etienne, and D. Éclache, *Laboratoires Phodé, Terssac, France.*

A blend of antioxidant and anti-inflammatory ingredients among which curcumin, formulated to be released in the intestine (Force 6 Poultry, Laboratoires Phodé, France), was tested on 2 groups (0 and 50 ppm doses in feed) of 6 replicate pens each containing 25 Ross x Ross broiler chickens, slaughtered at 35 d. A moderate heat stress was applied to induce an oxidative stress: temperature was increased beginning d 10 to 21 and d 29 to 34 from 3 to 6°C above Ross recommendations (during 12 h per day, see table). Birds were individually weighed at 21, 28, and 35 d. Feed conversion was evaluated per pen at each weighing and mortality was recorded daily. Liver glutathione peroxidase (GPx) activity was measured on 2 sacrificed birds per pen, chosen to be representative of the pen average weight, at 35 d of age ("Glutathione Peroxydase Assay Kit," Cayman chemical, Michigan, USA, method adapted from Paglia and Valentine, 1967). Performance data were subjected to mixed model procedure with treatment as fixed factor and pen in treatment as random factor, and chi-squared tests were performed on mortality rates (SAS v. 9.1, Cary, N.C.). Live weights at 28 and 35 d were improved ($P < 0.05$) in treated group (D28: 1883 g, D35: 2582 g) compared with control (D28: 1802 g, D35: 2509 g). Average daily weight gain was increased in treated group between 22 and 28 d (121.48 g/d vs 111.56 g/d for the control, $P < 0.05$). GPx activity was increased in treated group (94.14 vs 74.73 U/mg protein for control group, $P < 0.05$). Treatment has no significant effect on the other parameters ($P > 0.05$). In this trial, during a moderate heat stress, the product Force 6 Poultry improved chickens growth performances compared with a nonsupplemented control.

Table 1. Temperatures recommended (R) and applied in this trial (T); temperatures in bold indicate heat stress period

Temp, °C	Age, d															
	1-4	5-6	7-9	10	11-15	16-17	18-21	22-23	24-25	26-27	28	29	30-31	32	33-34	35
R	31	30	29	29	28	27	26	25	24	23	22	22	21	20	19	19
T	31	30	29	32	32	31	30	25	24	23	22	27	26	26	25	19

Key Words: broiler, antioxidant

W331 Effect of two chemotypes of oregano essential oil on growth performance and nutrient balance of broilers. C. Ariza-Nieto¹, W. Marquez¹, G. Afanador*², J. S. Knott³, and R. W. Fent³, ¹CORPOICA, Bogota, Colombia, ²Universidad Nacional, Bogota, Colombia, ³Ralco Nutrition Inc., Marshall, MN.

One alternative to feed-based antibiotics is oregano essential oil (OEO); however, there are many varieties and species of OEO. Two species of OEO were evaluated in this trial, a European strain (*Origanum vulgare* Hirtum) and a South American strain (*Lippia origanoides*). A 42-d experiment was conducted to evaluate growth performance using 2,000 one-day-old Ross male broilers housed in 40 pens. A separate trial was conducted using 200 broilers to determine organic matter, energy and nitrogen balance. The sources of OEO are the South American *Lippia Origanoides* (LO) and a commercially available oregano essential oil product Synergy Essence (SE; Ralco Nutrition Inc., Marshall, MN USA). For both experiments, experimental units were randomly assigned to 1 of 8 dietary treatments: (1) Basal diet (BD) without OEO or antibiotic; (2) BD+AGP (bacitracin 50 g/ton); (3) BD+LO125 (125 g/ton); (4) BD+LO250 (250 g/ton); (5) BD+LO500 (500 g/ton); (6) BD+SE125 (125 g/ton); (7) BD+SE250 (250 g/ton);

(8) BD+SE500 (500 g/ton). Data were analyzed by ANOVA as a completely randomized design. Each pen served as experimental unit. Tukey method was used to compare means ($P < 0.05$), and orthogonal single degree-of-freedom contrasts were used to compare means. Broilers fed SE250 had greater ($P < 0.05$) final body weight (2,295 g vs. 1,985 g) and greater ($P < 0.05$) ADG compared with the BD (53.9 g/d vs. 46.5 g/d). There were no differences ($P > 0.10$) among the LO, SE or AGP fed birds for ADG, ADFI, or gain:feed. Broilers consuming the AGP diet tended ($P < 0.10$) to have lower ADFI compared with the other dietary treatments. Broilers fed LO500 had greater ($P < 0.05$) organic matter digestibility than BD. There were no differences in organic matter, energy, or nitrogen digestibility among AGP, LO, or SE-fed birds. There was a tendency ($P < 0.10$) for BD-fed birds to have lower ME/GE compared with birds fed the AGP or OEO treatments. These data indicate that birds fed diets containing OEO grow faster than those fed a basal diet and similar to birds fed AGP with some of this response being possibly explained by increased digestibility and energy utilization.

Key Words: broiler performance, *Lippia origanoides*, *Origanum vulgare*

W332 An intimate combination of a high intensity sweetener and a phytonutrient improves performance of weaned piglets. C. Oguey¹, A. L. Wagner², and C. Bruneau*¹, ¹Pancosma S.A., Le Grand Saconnex, Geneva, Switzerland, ²Cooperative Research Farms, Richmond, VA.

Dietary levels of a high intensity sweetener based on saccharin are known to improve glucose absorption. Anethole was shown to enhance gut immunity and minimize local inflammation leading to optimal gut health. The objective of this trial was to evaluate the effects of an intimate combination of these 2 components (TT, TakTik X-In, Pancosma) on piglet's performance. Three hundred sixty weaning pigs (20 d of age, 5.5 ± 0.2 kg BW) were blocked based on weight and sex, and allocated to 36 pens for 6 weeks. Diets were supplemented with 264 ppm Cu, 2000 ppm Zn and antibiotics. During wk 1 to 3, pens were assigned to 2 treatments: a control (CT) unsupplemented basal diet (n = 12) or the basal diet + 150 ppm TT (TT; n = 24). During wk 4 to 6, the CT pens continued to receive CT, but the TT pens were split (n = 12) into 0 ppm TT (TT-S) or 150 ppm TT groups (TT-SG). Performance (ADFI, ADG, G:F) was recorded per pen and per phase and analyzed using PROC Mixed in SAS. From week 1 to 3 and compared to CT, TT increased ADFI (respectively 326.5 and 348.7 g/d, $P < 0.01$) and ADG (respectively 319.3 and 329.0 g/d, $P = 0.09$). During week 1, ADFI and ADG were similar among treatments ($P > 0.4$). However in weeks 2-3, TT increased ADFI by 7.6% ($P < 0.01$) and ADG by 3.1% ($P = 0.08$). These results suggest that TT does not target immediate performance, but improves intake and growth after enhancing gut development. During weeks 4-6, TT-SG improved ADG and G:F respectively by 4.9% and 4.5% compared to CT ($P < 0.05$) but did not affect ADFI (mean 858.0 g/d, $P = 0.78$). TT-S and CT exhibited similar ADFI, ADG and G:F in this phase ($P > 0.21$). This shows that a continuous TT supplementation improves piglets' performance during this period. On the overall, compared to CT, TT-SG did not affect ADFI (mean 585.05, $P = 0.34$) but enhanced ADG (respectively 453.7 and 472.9 g/d, $P = 0.01$) and G:F (respectively 784.8 and 800.0 g/kg, $P = 0.02$). These results show that TT improve performance of weaning piglets, through a better feed intake during the starter period, then via an increased feed efficiency during the grower phase.

Key Words: anethole, piglet performance, sweetener

W333 Effects of lactulose supplementation on production performance in sows and piglets. S. C. Kim, K. H. Kim, and I. H. Kim*, *Department of Animal Resource & Science, Dankook University, Cheonan, Choongnam, South Korea.*

A total of 18 sows (Landrace × Yorkshire) and their litters were used in this study to evaluate the effects of lactulose supplementation on performance in sows and piglets. On d 107 of gestation, all sows were relocated to farrowing crates in an environmentally regulated farrowing house, and allotted to 1 of 3 dietary treatment groups. Dietary treatments included (1) CON, control diet; (2) L1, CON + 0.1% lactulose; (3) L2, CON + 0.2% lactulose. All diets were provided in mash form, and sows were provided with free access to water throughout the experimental period. Individual piglet BW was assessed on d 0, 7, 14 and 21 (weaning), and 7 d after weaning to calculate ADG. Fecal *Lactobacillus* and *E. coli* shedding were measured by using MacConkey agar plates and lactobacilli medium III agar plates. The individual sow or litter of piglets was used as the experimental unit. All data in this experiment were analyzed in accordance with a completely randomized design using the GLM procedure (1996). Differences among treatment means were determined via Duncan multiple range test, and a probability level of $P < 0.05$ was regarded as statistically significant. At the weaning day (21 d), higher ($P < 0.05$) fecal *Lactobacillus* population of sows was observed in L2 treatment compared with CON treatment. In conclusion, our results suggested that dietary inclusion of lactulose at the level of 0.2% could increase the fecal *Lactobacillus* concentration in sows, but no beneficial effects were observed on the production performance either in sows or piglets.

Table 1. Effect of supplementation lactulose in lactating sows and piglets

Item	CON	L1	L2	SE
Sow BW, kg				
Before farrowing	234.6	235.7	239.2	15.1
After farrowing	214.1	217.9	219.2	12.9
Weaning	207.8	206.7	212.9	13.8
BW loss	6.3	11.2	6.3	3.6
Piglets				
Birth weight, kg	18.3	18.5	18.5	1.2
Weaning weight	59.2	65.7	67.2	5.0
ADG, g	211	217	225	13.8
Weaning <i>Lactobacillus</i> , log ₁₀ cfu/g	6.45 ^b	6.88 ^{ab}	7.02 ^a	0.17

^{a,b}Means in the same row with different superscripts differ ($P < 0.05$).

Key Words: lactulose, piglet, sow

W334 Effect of propolis on the growth performance, nutrient digestibility, blood profiles, fecal microflora, fecal score, and intestinal morphology in weanling pigs. B. R. Lee, J. Li, and I. H. Kim*, *Department of Animal Resource & Science, Dankook University, Cheonan, Choongnam, South Korea.*

A total of 125 pigs [(Yorkshire × Landrace) × Duroc] with an average initial BW of 6.68 ± 1.03 kg were used to investigate the effects of propolis on growth performance, nutrient digestibility, blood profiles, fecal microflora, fecal score, and intestinal morphology in weanling pigs in this 5-wk trial. Pigs were randomly allocated into 1 of 5 dietary treatments on the basis of BW and sex [5 replicate pens per treatment with 5 pigs (2 gilts and 3 barrows) per pen]. Propolis feed additive contained more than 60% propolis and 6% of total flavonoid in powder form. Dietary treatments were (1) NC, negative control (free antibiotics); (2) PC, NC + 33 ppm tiamulin; (3) PRO1, NC + 0.05% propolis;

(4) PRO2, NC + 0.10% propolis; (5) PRO3, NC + 0.20% propolis. At the end of wk 2 and wk 5, individual pig BW and feed consumption was recorded on a pen basis to calculate growth performance, nutrient digestibility was measured following the procedures by the AOAC (2000), blood profiles and fecal microflora were analyzed. All data were subjected to the GLM procedures of SAS (1996) as a randomized complete block design, with pen as the experimental unit. Pigs fed PRO1, PRO2 and PRO3 diets had higher (378, 382 and 389 vs. 352 g; $P < 0.05$) ADG than pigs fed NC diet during wk 0 to 2. During d 0 to 35, the ADG in PRO2 and PRO3 was higher (492 vs. 459 g; $P < 0.05$) than NC, the gain/feed in PRO3 was higher (0.849 vs. 0.765; $P < 0.05$) than NC. Apparent total tract digestibility (ATTD) of DM and N of NC was lower (DM: 80.78 vs. 83.65%; N: 79.14 vs. 82.46%; $P < 0.05$) than other treatments at wk 2. PRO1, PRO2 and PRO3 treatments had higher (84.17 vs. 80.02%; $P < 0.05$) ATTD of energy compared with NC treatment at 2 wk. The concentration of IgG in PRO2 was higher (381 vs. 319 mg/dL; $P < 0.05$) than NC at 5 wk. Fecal score in NC and PC treatments were higher (4.0 vs. 3.4; $P < 0.05$) than in PRO2 treatment at 1wk. In conclusion, inclusion of propolis at a level of 0.10% could increase growth performance, nutrient digestibility, IgG, and had positive effect on fecal score in weanling pigs.

Key Words: growth performance, propolis, weanling pig

W335 Effect of phytochemicals on growth performance, calcium and phosphorus digestibility, and bone calcium and phosphorus contents in broilers. Z. F. Zhang, B. R. Lee, and I. H. Kim*, *Department of Animal Resource & Science, Dankook University, Cheonan, Choongnam, South Korea.*

A total of 756 day-old broilers (40 ± 0.2 g) were used in a 28-d feeding trial to evaluate the effects of phytochemicals on calcium (Ca) and phosphorus (P) digestibility, and bone Ca and P contents which affected the bone strength and growth performance. Broilers were randomly distributed into 1 of 7 treatments on the basis of BW (6 replicate pens per treatment with 18 broilers per pen). Phytochemicals (Biostrong 510, Delacon, Austria) contains 30% Quilaja, 20% Anise and 17% Thyme. Dietary treatments were: T1, negative control (without antibiotic); T2, CP 0.5% reduced; T3, CP 0.5% reduced + 0.015% phytochemicals; T4, Ca 0.07% reduced + P 0.065% reduced; T5, Ca 0.07% reduced + P 0.065% reduced + 0.015% phytochemicals; T6, T1 + 0.015% phytochemicals; T7, T1 + 0.2% mixed organic acids (20% formic acid, 20% lactic acid, 10% citric acid and 10% fumaric acid). The broilers were weighed and feed intake were recorded on d 1, 7, 21 and 28 for calculating BW gain (BWG), ADFI, and feed conversion ratio (FCR). At d 28, fresh excreta samples were collected from each pen for the measurement of nutrient digestibility according to the procedures of AOAC (2003). All data were subjected to GLM procedures of SAS (1996) as a randomized complete block design, with pen as the experimental unit. Differences among treatments were separated by Duncan's multiple range test; $P < 0.05$ was considered statistically significant. There was no difference ($P > 0.05$) in BWG, ADFI and FCR among treatments. The apparent total tract digestibility (ATTD) of Ca in T7 treatment was higher ($P < 0.05$) than in T1, T2 and T3 (0.58 vs. 0.52, 0.53 and 0.52). Broilers fed the T2 diet had a lower ($P < 0.05$) ATTD of P than T1, T3, T5, T6, and T7 (0.47 vs. 0.55, 0.55, 0.54, 0.55 and 0.55). At wk 4, bone Ca in T6 was increased (10.76 vs. 9.71 g/100g DM; $P < 0.05$) compared with T4, bone P of T5, T6 and T7 increased ($P < 0.05$) compared with T4 (5.29, 5.30 and 5.29 vs. 5.13 g/100g DM). In conclusion, phytochemicals could improve bone calcium and phosphorus of broilers. Mixed organic acids improve the ATTD of Ca and P, and increased bone phosphorus in broilers.

Key Words: bone calcium and phosphorus, broiler, phytochemicals

W336 Effects of microencapsulated organic acids and pure botanicals (Aviplus-S) supplementation on reproductive performance, nutrient digestibility, and fecal scores in lactating sows and piglets. J. H. Cho, H. Y. Beak, and I. H. Kim*, *Department of Animal Resource & Science, Dankook University, Cheonan, Choognam, South Korea.*

A total of 21 crossbred (Yorkshire × Landrace) sows were used to determine the effects of microencapsulated organic acids and pure botanicals (Aviplus-S) supplementation on reproductive performance, nutrient digestibility, and fecal scores in lactating sows and piglets. Microencapsulated feed additive (Aviplus-S, VetAgro SpA, Reggio Emilia, Italy) contains 25% citric acid, 16.7% sorbic acids, 1.7% thymol and 1.0% vanillin. Sows were randomly allotted into 1 of 3 dietary treatments. Treatments were (1) CON, control diet; (2) Avi1, CON + 0.05% Aviplus-S; (3) Avi2, CON + 0.10% Aviplus-S. Experimental stage was from 2 weeks before farrowing to weaning (weaning period 25 d). Fresh fecal grab samples collected from each sow on d 25 after farrowing were mixed and pooled, and analyzed for nutrient digestibility of DM, gross energy and nitrogen following the procedures of AOAC (2000). Fecal consistency was monitored twice daily during d 5 to d 25 after farrowing and quantified using a scale ranging from 0 to 5. When the scoring was bigger than 3, the piglet was considered to have diarrhea. Data will be analyzed using a randomized complete block design following GLM procedures of SAS (1996), with each sow being used as the experimental unit. Sows fed Avi2 diet had higher ($P < 0.05$) BW a few hours before farrowing, a few hours after farrowing and at the day of weaning compared with sows fed CON and Avi1 diets. No significant difference ($P > 0.05$) was observed in nutrient digestibility among treatments. During d 5 to 8, d 16, fecal score were decreased ($P < 0.05$) in treatment Avi1 compared with CON treatment. Avi1 and Avi2 diets had lower ($P < 0.05$) fecal score than CON diet from d 20 to 22. The number of diarrhea piglets was decreased ($P < 0.05$) when sows were supplemented with 0.10% Aviplus-S compared with CON treatment at d 15. In conclusion, this study indicates that administration of 0.10% Aviplus-S could decrease the BW loss after farrowing, and dietary inclusion of 0.05 or 0.10% Aviplus-S could improve the fecal score in piglets.

Key Words: organic acid, pure botanical, sow

W337 Evaluation of Flavomycin 4 (bambermycins) and Stafac 20 (virginiamycin) in growing-finishing pigs' growth performance and carcass characteristics under different environmental temperatures. S. K. Baidoo*, J. A. Jendza¹, and R. Cabrera², ¹*University of Minnesota, Southern Research and Outreach Center, Waseca,* ²*Huvena-pharma Inc., Chapel Hill, NC.*

Two feed additives, Flavomycin (FLAV) and Stafac (STAF), were evaluated in growing-finishing pigs under different environmental temperatures in a 49-d growth performance study. Growing-finishing pigs ($n = 397$, 87.9 ± 7.2 kg) were allotted to 3×2 factorial arrangement with 3 dietary treatments (CON; FLAV (250ppm), STAF (250 ppm) and 2 environmental temperatures (Normal Temp (N) = 18°C and High Temp (H) = 30°C). Forty-eight pens of growing-finishing pigs (7 to 8 pigs per pen) divided evenly between 3 rooms with 2 designated as H Temp rooms and one as N Temp room. Pen BW was used to assign pens to treatments in a randomized incomplete block design. A basal diet was formulated using 54% corn, 30% corn-derived DDGS and 10% SBM to contain 3,124 kcal ME/kg, 0.96% SID Lys, 0.65% Ca and 0.38% available P. Pigs were weighed and blood samples (for BUN and IgG analyses) collected on d 0, 28 and 49 of the study. Carcass traits were measured at slaughter. Statistical analysis was for a randomized incom-

plete block design with block nested within temp. Statistical significance was set at $P < 0.05$. Heat stress (H) reduced ($P < 0.01$) BW, ADFI and ADG at all time points but improved ($P < 0.01$) feed efficiency d0 to d28. Dietary treatment did not interact with environmental temperature, or exert an independent effect on growth performance measures. Blood urea nitrogen was not affected by any treatment, but increased ($P < 0.05$) with time. Plasma IgG was not affected by diet, but was increased by high environmental temperature on d 28 ($P < 0.05$) but not on d 49 and was reduced with time ($P < 0.01$). For carcass characteristics, H Temp reduced HCW yield ($(107 \pm 0.04$ kg vs. 95 ± 0.59 kg; $P < 0.01$), back fat depth ($(19.8 \pm 0.25$ mm vs. 23.1 ± 0.50 mm; $P < 0.01$) and loin depth ($(72.9 \pm 0.51$ mm vs. 74.4 ± 0.5 ; $P < 0.04$) but increased ($(55.1 \pm 0.13$ vs. 54.9 ± 0.18 ; $P < 0.05$) percent lean yield. Dietary supplementation with either FLAV or STAF did not mitigate the heat stress related feed suppression and there was no interaction between diet and temperature.

Key Words: environmental temperature, pig, Flavomycin

W338 Effect of antimicrobials on energy and phosphorus utilization in pigs. K. McCormick* and O. Adeola, *Purdue University, West Lafayette, IN.*

The improvement in energy and nutrient utilization may be a contributing factor in the growth-promoting benefits of antimicrobials. The current study evaluated the effect of 3 antimicrobials (carbadox, tylosin, or virginiamycin) on total tract utilization of energy and P in 17-kg pigs fed a P-deficient corn-soybean meal-based diet. Twenty-four barrows blocked by weight (17.5 ± 0.41 kg) and housed in metabolism crates were assigned in randomized complete block design to dietary treatments that included (1) negative control (NC), (2) NC plus 55g/T carbadox, (3) NC plus 44 g/T tylosin, and (4) NC plus 11 g/T virginiamycin. The NC diet contained 0.7% Ca, and 0.4% total P. Pigs were fed twice daily at an allowance of 4% of BW. A 5-d adaptation period preceded a 5-d total collection period, with chromic oxide as a marker to determine initiation and termination of fecal collection. The results show that the supplementation of antimicrobials did not affect DM digestibility (87.1%, 88.5%, 87.0%, and 87.7%, respectively), P absorption (35.1%, 34.0%, 31.5%, and 38.3%, respectively), DM retention (81.8%, 82.9%, 80.7%, and 82.7%, respectively), or P retention (34.8%, 33.7%, 31.0%, and 38.0%, respectively). There was an increase in energy digestibility ($P = 0.02$, 86.5% and 88.1%) and retention ($P = 0.03$, 83.4% and 84.9%) with supplementation of carbadox relative to pigs fed the NC diet. Furthermore, supplementation of virginiamycin showed a tendency to improve energy retention relative to the NC diet ($P = 0.10$, 83.4% and 84.5%). Results from the current study show that supplementation of carbadox improved energy utilization, whereas virginiamycin improved energy retention, although there were no changes in DM and P utilization.

Key Words: antimicrobial, phosphorus digestibility, pig

W339 Effects of turmeric and curcumin addition to diets on growth performance and immune response of nursery pigs. M. R. Bible*, S. D. Carter, K. F. Coble, H. J. Kim, and T. M. Walraven, *Oklahoma State University, Stillwater.*

Curcumin is an active component in turmeric that has antimicrobial and anti-inflammatory properties, which may aid in improving growth performance of nursery pigs. Thus, 216 (5.8 kg; 8 reps/trt) crossbred [D × (L × Y)] pigs were used to determine the effects of curcumin on growth performance and immune response of nursery pigs. Pigs were weaned at 20 d of age, blocked by BW and ancestry, and allotted randomly to

4 dietary treatments in a randomized complete block design (RCBD). Standard corn-soybean meal-based diets were fed in meal form in a 4-phase feeding program (SID Lys 1.56, 1.51, 1.31, 1.25%). Diets were a negative control (no antibiotic; CNT), a positive control (mecadox, 55 mg/kg; AB), CNT + 2 g/kg of turmeric powder (TUM), and CNT + 80 mg/kg of curcumin powder (CUR). AB, TUM, and CUR replaced corn in the diets. ADG, ADFI, and G:F were calculated for d 0–21 and 0–42. On d 20, 1 pig/pen was challenged with *E. coli* lipopolysaccharide (LPS; 25 µg/kg BW intraperitoneal). Rectal temperatures (RT) were measured and blood collected for analysis of tumor necrosis factor- α (TNF- α) at 0, 3, 6, 12, and 24 h post-injection (PI). Growth data were analyzed as a RCBD using a general linear model; immune response analysis used a mixed model with repeated measures. For d 0–21, ADG for pigs fed AB (324 g) was greater ($P < 0.05$) compared with pigs fed CNT (294 g) or TUM (293 g), with pigs fed CUR (317 g) intermediate. There was a tendency ($P < 0.10$) for ADFI to be lower for pigs fed TUM (453 g) than pigs fed AB (489 g), with pigs fed CNT (466 g) and CUR (468 g) intermediate. Pigs fed CUR (0.68) had greater ($P < 0.05$) G:F than pigs fed CNT (0.63), with G:F similar for pigs fed AB (0.66) and TUM (0.64). Results for d 0–42 were similar to d 0–21, but there were no effects on ADFI. RT and TNF- α increased ($P < 0.01$) from hr 0, peaked at 3 h, and returned to normal by 24 h PI of LPS. For TNF- α (ng/mL), pigs fed CUR (2.8) had the smallest increase ($P < 0.01$) at hr 3 PI, followed by AB (3.8), CNT (5.1), and finally, TUM (5.3). In conclusion, pigs fed CUR had similar growth performance to AB and CUR blunted the response to a LPS challenge.

Key Words: pig, curcumin, turmeric

W340 Effect of supplementing a nucleotide-rich yeast extract without or with in-feed antibiotics on performance and total-tract nutrient digestibilities in weaned piglets. S. M. Waititu^{*1}, J. M. Heo¹, R. Patterson^{1,2}, and C. M. Nyachoti¹, ¹University of Manitoba, Winnipeg, MB, Canada, ²Canadian Bio-Systems Inc., Calgary, AB, Canada.

Dietary nucleotides are bioactive compounds with the potential to mitigate weaning-associated challenges in piglets. Two experiments were carried out to determine the effect of supplementing a nucleotide-rich yeast extract (NRYE) in a piglet diet with or without an antimicrobial growth promoter (AGP) on performance and apparent total tract digestibility (ATTD) of DM, CP and GE. In Exp. 1, ninety 21-d-old piglets (initial BW 6.79 ± 0.5 kg; mean ± SD) were randomly assigned to 6 dietary treatments consisting of a basal corn-soybean meal-based diet containing 0, 0.1, or 0.2% NRYE each fed with or without AGP (55 mg of Aueromycin and 31.2 mg of Tiamulin per kg of diet) in a 3 × 2 factorial arrangement for a 21-d period. In Exp. 2, 6 corn-soybean meal-based diets formulated to contain 0% NRYE or 0.1% NRYE with 0, 25, 50, 75 or 100% of the recommended AGP dosage were fed to 108, 21-d-old piglets (initial BW 7.11 ± 0.9 kg; mean ± SD) for 28 d. Dietary treatment did not influence growth performance in both experiments. In Exp. 1, supplementing 0.1% NRYE reduced ($P < 0.05$) occurrence of loose feces compared with 0.2% NRYE, and AGP supplementation with 0.2% NRYE reduced ($P < 0.05$) the ATTD of DM, CP and GE. In Exp. 2, supplementing 50% AGP with 0.1% NRYE reduced ($P < 0.05$) occurrence of loose feces and increased ($P < 0.05$) the ATTD of CP and DM in wk 3. Increasing AGP concentration linearly ($P < 0.05$) decreased and increased ADFI and G:F in wk 3, respectively, increased ADG in wk 4, and quadratically ($P < 0.05$) reduced occurrence of loose feces from wk 2 to 4 and overall. The results show that supplementing 0.1% NRYE with 50% AGP would have beneficial effects in reducing occurrence of loose feces in piglets and increasing ATTD of DM and

CP but further research is needed to explain the lack of response in growth performance.

Key Words: antimicrobial growth promoter, nucleotide-rich yeast extract, performance

W341 Effect of two chemotypes of oregano essential oils on lipid peroxidation of broiler breast meat during storage. C. Ariza-Nieto^{*1}, D. Vasquez¹, G. Afanador², J. S. Knott³, and R. W. Fent³, ¹CORPOICA, Bogota, Colombia, ²Universidad Nacional, Bogota, Colombia, ³Ralco Nutrition Inc., Marshall, MN.

Oregano essential oil (OEO) is powerful natural antioxidant. A feeding study was conducted to evaluate the effects of 2 chemotypes of OEO on oxidative stability of breast meat. The sources of OEO are the South American *Lippia origanoides* (LO) and a commercially available oregano essential oil product Synergy Essence (SE; Ralco Nutrition, Inc. Marshall, MN USA). One-day-old Ross broilers were randomly assigned to 1 of 8 dietary treatments: (1) Basal diet (BD) without OEO or antibiotic; (2) BD+AGP (bacitracin 50 g/ton); (3) BD+LO125 (125 g/ton); (4) BD+LO250 (250 g/ton); (5) BD+LO500 (500 g/ton); (6) BD+SE125 (125 g/ton); (7) BD+SE250 (250 g/ton); (8) BD+SE500 (500 g/ton). At the time of slaughter (42 d of age), 5 birds per treatment were selected and slaughtered. A portion of the breast was minced with a conventional meat grinder. Three subsamples were wrapped in an oxygen-permeable polyethylene film and stored at -4°C for 3, 6, and 9 d, then were vacuum-packed and stored at -20°C until analysis. Lipid peroxidation was determined by measuring malondialdehyde (MDA) concentration in samples from each day. Data were analyzed by ANOVA as a completely randomized design with a factorial arrangement of treatments (8 × 4) with 4 replicates. Tukey method was used to compare means ($P < 0.05$). As day of storage increased (0, 3, 6, 9), MDA concentration increased ($P < 0.05$) from 49.3 to 116.2 ng/g MDA. Broilers fed SE500 had lower ($P < 0.05$) MDA concentration than BD and AGP fed birds. Within OEO supplementation chemotypes at all levels, no differences in MDA ($P > 0.10$) were observed. This study illustrates that providing OEO from SE at 500g/ton in the diet of broilers results in lower lipid peroxidation in ground breast meat throughout the time of storage tested.

Key Words: breast meat, lipid stability, oregano essential oil

W342 Do phytochemicals interact with exogenous xylanase when fed to broiler chicks? V. Pirgozliev^{1,3}, D. M. Bravo^{*2}, and S. P. Rose³, ¹Avian Science Research Centre, Scottish Agricultural College, Ayr, UK, ²Pancosma, Geneva, Switzerland, ³National Institute of Poultry Husbandry, Harper Adams University College, Newport, UK.

The aim of the study was to investigate the effects of dietary supplementation of a mixture of carvacrol, cinnamaldehyde and capsaicin (XT, Pancosma S.A.) alone or combination of XT and xylanase (XYL; a commercial xylanase preparation) on N-corrected dietary apparent metabolizable energy (AMEn) and bird growth performance. A total of three hundred male day-old Ross 308 chicks reared in floor pens from day old to 21 d age, and were fed 1 of 3 diets. A basal diet was prepared that had major ingredients of 546.8 g/kg wheat and 274.9 g/kg soybean meal, and contained 215 g/kg crude protein and 12.12 MJ/kg. The basal diet was then split on 3 batches and supplemented with either no additive (control diet), or 100 g/t of XT (XT diet), or combination of XT and XYL at the rate of 100 g and 2000 units of xylanase/kg (XYL diet). The treatments were allocated in a randomized complete block design with each treatment having 10 replicate floor pens with 10 birds

per pen. Birds fed XT and XYL diets grew 18.5 and 10.7%, respectively, faster ($P < 0.05$), and converted about 9.5% more efficiently the feed to gain, when compared with control fed birds only. There was no difference ($P > 0.05$) in weight gain and feed efficiency between birds fed XT and XYL based diets. Experimental diets did not differ in AMEn ($P > 0.05$), but birds fed XT alone had 10 and 5.5%, respectively, higher daily metabolizable energy intake ($P < 0.05$) than birds fed control and XYL diets. For each gram of weight gain, birds fed XT and XYL diets on average consumed 6.1% less AMEn ($P < 0.05$) than birds fed the control diet only, resulting in proportionately more dietary metabolizable energy intake being available for production as opposed to maintenance. It can be concluded that there were no negative interactions between XT and xylanase when added to a wheat soybean diet and fed to broilers.

Key Words: phytonutrient, xylanase, metabolizable energy

W343 Effects of Healthy Edge technology on sow and litter performance. S. D. Carter*¹, B. de Rodas², K. F. Coble¹, H. J. Kim¹, M. R. Bible¹, and G. Willis², ¹Oklahoma State University, Stillwater, ²Purina Animal Nutrition Center, Gray Summit, MO.

A cooperative study, utilizing 315 primi- and multiparous crossbred sows from 2 stations (OSU, Purina Animal Nutrition Center), was conducted to determine the effects of inclusion of Healthy Edge in corn-soybean meal diets during the last 6 weeks of gestation through lactation on sow and litter performance. Sows were allotted, based on weight and parity within station, 6 weeks before farrowing to 2 dietary treatments. The

control (C) diet was a fortified corn, soybean meal diet (n = 155 sows). Healthy Edge (HE) was added to the control diet at 0.05% at the expense of corn to formulate the test diet (n = 160 sows). The HE contained a select combination of immune-modulating compounds. The gestation and lactation diets were formulated to 0.5 and 0.95% standardized ileal digestible Lys, respectively. Both the gestation and lactation diets contained 0.85% Ca and 0.39% available P. Sows were fed 2.2 kg/d in gestation and allowed ad libitum access to feed in lactation. Sows were weighed at d 109 of gestation, within 24 h after farrowing, and at weaning. Data were analyzed as a mixed model with station, trt, and interactions tested. Sow (litter) served as the experimental unit. Litters were weighed within 24 h of parturition and at weaning. Average sow parity (3.0), lactation days (19.4 d), ADFI (6.0 kg), sow weight post-farrowing (224 kg) and weaning (239 kg), and sow weight change (-4.4 kg) were similar ($P > 0.10$) for both diets. However, number born (11.5 vs. 12.7), number born alive (10.1 vs. 11.4), and number weaned (9.3 vs. 10.0) were increased ($P < 0.004$) for sows fed HE compared with C. Pig weight at birth and weaning were not affected ($P > 0.10$) by diet, but because of greater no. of pigs, litter weights at birth (16.8 vs. 17.7 kg) and weaning (59.2 vs. 63.6 kg), and litter weight gain (42.7 vs. 46.2 kg) were increased ($P < 0.02$) for sows fed HE. Also, sows fed HE returned to estrus sooner ($P < 0.01$) compared with C sows. There were no station \times treatment interactions ($P > 0.10$). These results indicate that HE increased number of pigs born alive and weaned, increased litter weight gain, and reduced days to return to estrus.

Key Words: sow, diet, lactation