
Increased usage of an anticoccidial containing lower inclusion levels in a combined product of the ionophore narasin and the chemical nicarbazin over the past decade has raised the question of whether nicarbazin’s efficacy remains unchanged. This led to an examination of anticoccidial sensitivity results from Eimeria spp. isolated from litter samples collected from 2004 to 2013 from 68 broiler production complexes across the United States. All data were analyzed using the GLM procedure of SAS (SAS Institute, 2004). Differences in performance and lesion scores among treatments were determined by Duncan’s new multiple range test, a probability of \( P < 0.05 \) was used to determine significance. Analysis of the data showed that based on presence of gross lesions, the most prevalent species was Eimeria acervulina (80.9%) followed by Eimeria tenella (35.3%) and Eimeria maxima (19.1%). An isolate is considered to be sensitive if the lesion scores are reduced by 50% or more when compared with the infected, unmedicated controls, by this definition, the efficacy of nicarbazin has not significantly \( (P < 0.05) \) changed during the last decade. Likewise, when performance parameters such as body weight gain and feed conversion ratio were used to evaluate the effectiveness of nicarbazin by comparing the body weight gain and feed conversion of nicarbazin-treated birds vs. those of negative (uninfected, unmedicated) and positive (infected, unmedicated) controls, no significant \( (P < 0.05) \) change in the efficacy of nicarbazin was observed during the past 10 yr.

Key Words: nicarbazin, anticoccidial, sensitivity, coccidiosis, chickens


A floor pen experiment was conducted to evaluate the effects of Nutrafito Plus (NFP, Phibro Animal Health), both alone and in combination with virginiamycin (Vm), on the performance and anticoccidial effects following vaccination for coccidiosis. NFP, a saponin-containing feed additive, was included in feeds at 0, 200, and 250 ppm and Vm was supplemented at 0 and 22 ppm in a 3 × 2 factorial design. All broilers were vaccinated for coccidiosis at day-of-hatch and medicated feeds were provided from placement until d 42. Performance was measured at d 18, 28 and 42 and oocyst counts per gram of feces were determined at d 21, 28 and 35. At d 21, 5 birds from each pen were removed, exposed to a challenge dose of Eimeria spp., and placed in cages where they were maintained for 7 d. To assess their acquired immunity to coccidial challenge, these birds were killed 7 d post-infection and scored for lesions. Results of this evaluation indicated that, compared with nonmedicated controls, NFP significantly improved feed conversion at 18, 28 and 42 d of age \( (P < 0.05) \); feed conversion at these times was further improved by Vm \( (P < 0.05) \), but no interactive effects of the additives were observed. On d 21, NFP (both 200 and 250 ppm) significantly reduced total oocysts per gram of feces \( (P < 0.05) \). In addition, birds exposed to NFP for 21 d and then challenged with coccidia in separate cages had higher lesion scores than controls following Eimeria challenge \( (P < 0.05) \). Taken together, these results indicate that NFP exerted an anticoccidial effect which provided consistent improvements in feed conversion when used in combination with a coccidiosis vaccine.

Key Words: Nutrafito Plus, virginiamycin, coccidiosis, performance, coccidia vaccination


In 1970, J. Johnson and W. M. Reid published a lesion scoring method to evaluate gross coccidial lesions in chickens. The goal was to standardize lesion scoring among researchers but poultry industry veterinarians adopted the technique for routine monitoring of coccidiosis; however, the current use is substantially different from that described in the publication. The authors abandoned all attempts to score by species, and instead recorded the degree of coccidial damage to 4 regions of the intestinal tract. They noted that scoring lesions for Eimeria maxima and Eimeria brunetti was very difficult, that their technique requires a minimum of 2 but ideally 3 people, that the serosal surface of the intestines should be examined for lesions first under a strong light, that a similar examination of the mucosal surface with collection of shallow and deep scrapings for microscopic examination should be conducted, that lesion scoring should be conducted by one person with no knowledge of treatments, and that no more than 200 birds should be examined in a day by a team of 3. Observations from the field showed that people conducting lesion scoring report findings by species rather than region, that evaluators tend to increase the severity of the infections by one level, that most individuals conduct the scoring and microscopic examination by themselves, that individuals conducting the scoring session usually have knowledge of the anticoccidial program, that the individual conducting the scoring usually does not examine the serosal surface throughout the length of the intestines before examining the mucosal surface, that most reports give the incidence of coccidiosis or the incidence of each coccidial species by age but very few provide the mean lesion score by flock and the average lesion score for the necropsy session, that some individuals do not collect mucosal scrapings for microscopic examination and that an experienced evaluator has scored up to 2,000 birds in a period of 3 h. In conclusion, few if any of us follow the method developed and published in 1970 by Johnson and Reid as originally described.

Key Words: coccidiosis, intestinal lesion scoring, chicken


Enteric inflammation models with robust means to induce and measure gut leakage in poultry have many applications in both production and research. These models can help to connect gut health with performance, and evaluate various growth promoters as well as dietary formulations targeted to improve performance in poultry. Oral administration of fluorescein isothiocyanate dextran (FITC-d; 3–5 kDa) and its pericellular mucosal epithelial leakage into blood can be used as a marker to evaluate enteric inflammation in poultry, similar to previous reports in rodents. In a study conducted in our laboratory, 0.75% dextran sodium sulfate (DSS) in drinking water and 24h feed restriction (FR) were compared as potential methods to induce gut leakage in broilers. Both DSS and
FR resulted in higher ($P < 0.05$) serum FITC-d levels when compared with controls, suggestive of increased gut leakage. In addition, duodenal and cecal sections from FR showed increased ($P < 0.05$) retention of FITC-d. In another experiment, effect of different diet formulations along with 0.75% DSS and FR on broiler gut health was compared. Treatment groups (n = 12 birds/group) were DSS (0.75% in drinking water), high fat diet (HFD; 6.6% poultry oil), HFD + DSS, rye-based diet (RBD) and FR. All groups, except HFD and RBD groups, were fed with diet containing 3.3% poultry oil. Also, effects of 0.45 g of DSS/bird as oral gavage (OG-DSS) and FR on bacterial translocation were compared in a different set of birds (n = 20/group). The RBD and FR groups showed higher ($P < 0.05$) levels of serum FITC-d when compared with control birds. In addition, HFD + DSS, RBD, and FR resulted in increased ($P < 0.05$) retention of FITC-d in duodenal mucosa. Moreover, FR birds had higher ($P < 0.05$) level of FITC-d retained in ceca tissue compared with all other groups in the study. Results from our study also showed that FR, similar to OG-DSS, can result in increased ($P < 0.05$) bacterial translocation in chickens. From these studies, it can be concluded that different diet formulations, such as HFD and RBD, can cause increased gut leakage, similar to FR and DSS, which could result in increased bacterial translocation in chickens.

Key Words: dextran sodium sulfate, serum FITC-d, bacterial translocation, gut leakage, feed restriction


A study was performed at the Auburn University (AU) Poultry Research Farm using Eimeria spp. isolated from pooled poultry litter samples collected from 3 poultry complexes. Each complex sampled consisted of 6 to 8 litter samples. Samples were homogenized with equal portions of litter, and standard Eimeria isolation techniques were used for oocyst isolation and sporulation. Three trials were conducted to examine the effect of these mixed coccidia isolate challenge on live production values and lesion scores. Each study consisted of 6 medicated feed groups: untreated/uninfected (A), untreated/infected (B), diclazuril (C), robenidin (D), amprolium (E) and decoquinate (F). Each treatment group consisted of 3 replicates containing 6 male chicks/rep (108 male chicks/study). Chicks were fed AU starter for 12 d then switched to medicated feed 2 d (d 13) before Eimeria challenge. Treatments B to F were administered 100,000 sporulated mixed Eimeria spp. oocysts per bird on d 15. Mortalities were recorded from d 13 to 21. On d 21, bird pen and feed weights were recorded. Birds were necropsied and lesion scores were taken for the duodenum, jejunum, ileum and ceca. Feed conversion, body weight and lesion scores were analyzed using GLM if significant ($P < 0.05$) means were separated using Tukey's HSD. FCR and d 13–21 BW for trials 1 and 3 showed no significance between treatments. For trial 2, FCR for B (1.77) was significantly higher than that for A, C, D, E, and F (1.34, 1.40,1.42, 1.43,1.41 kg, respectively). Day 13–21 pen BW for A, C, D, E, and F (4.69, 4.44, 4.48, 4.34, 4.50 kg) were favorable compared with that for B (3.53). Lesion scores for the 3 studies showed significance with respect to lesion severity, but there was variability dependent upon the region scored. When comparing the intestinal regions that were scored, no single treatment gave consistent results like the unchallenged control treatment. These data show that anticoccidial use can influence FCR, body weight, and lesion severity. Other factors such as variability in Eimeria spp. and resistance to medications can affect live production values as well as lesion severity.

Key Words: coccidia, lesion, FCR


This study assessed gut health feeding strategies that use continuous application (908 g/t for d 18–35 or 908 g/t for d 0–42) of a proprietary mixture of organic minerals, yeast cell wall oligosaccharides and plant extracts manufactured from Alltech Inc. (Natustat), a combination of strain specific mannan-rich fractions from yeast (Actigen; 400 g/t d 0–18, 200 g/t/d 18–42) and Natustat (908 g/t d 18–35), or a low level (40 g/t d 18–35) of the antimicrobial anticoccidial ionophore salinomycin. Using these 4 supplement strategy treatments and a non-medicated control, a 42-d floor pen trial was conducted. There were 8 replications of each treatment. Cobb 500 male broiler chicks were vaccinated for coccidia at hatch. Each pen contained 50 chicks with 0.93 sq. ft per chick. A 3 phase dietary program was used based on commercial feed formulation standards: starter, d 0–18; grower, d 18–35; and finisher, d 35–42. Bird weights and feed consumption were measured on d 18, 35, and 42. Oocysts per gram fecal material (OPG) were determined weekly; OPG indicated that the peak of coccidiosis occurred between d 21 and 28. At d18 only the birds fed mannan rich fractions had a significantly ($P < 0.05$) improved feed conversion ratio (FCR). At d 35, benefits for all strategies were observed with significantly ($P < 0.05$) lower FCR and OPG compared with NM birds. Day 42 benefits of all feed additives were greater with significantly ($P < 0.05$) higher weight gains, lower FCR, and lower OPG compared with NM birds. The combination treatment had the best performance followed by the salinomycin strategy, the d 0–42 Natustat strategy, and then d 18–35 Natustat strategy. All feeding strategies modulated coccidiosis and improved performance. Continuous feeding of Natustat improved performance compared with the Natustat only during the peak of coccidiosis infection strategy. Actigen did not demonstrate any anticoccidial activity. Thus the combination strategy may have beneficially modulated coccidiosis leading to improved performance.

Key Words: Actigen, Natustat, salinomycin, coccidiosis, anticoccidial

121 Performance of broiler chickens fed Saccharomyces cerevisiae type boulardii and challenged with Clostridium perfringens. G. Mathis*, B. Lumpkins, C. Hofacre2, M. Masadeh, and E. Keith3,1Southern Poultry Research Inc., Athens, GA, 2University of Georgia, Athens, GA, 3Lallemand Animal Nutrition, Milwaukee, WI.

The objective of a battery cage study was to evaluate the performance and level of Necrotic Enteritis of broiler chickens issued Saccharomyces cerevisiae type boulardii (SCB) or the antibiotic Virginiamycin (VIR) and challenged with Clostridium perfringens. It has been demonstrated that Saccharomyces cerevisiae type boulardii aids in establishing a balanced intestinal microbiota population. The study used a randomized block design with 8 replications of 8 birds per cage. The treatments were nonmedicated nonchallenged (NMNC), nonmedicated challenged (NMC), SCB dose 1 (1 × 10⁹ cfu/kg), SCB dose 2 (2 × 10⁹ cfu/kg), and VIR (20 g/l). Day of hatch chicks were placed into cages and issued treatment feeds (d 0). Treatment feeds were available ad libitum throughout the experiment (d 0–28). On d 14, birds were challenged with Eimeria maxima and on d 18,19, and 20 with Clostridium perfringens. On d 21, 3 birds per cage were scored for necrotic enteritis (NE) lesions (scoring range 0–3). The parameters measured were feed conversion and weight gain, NE mortality, and NE lesion scores. The data were analyzed with

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a P-value of 0.05 to determine the level of significance. There was a significant (P < 0.05) improvement in performance (feed conversion and weight gain) at d 0 to 21, d 14 to 21 (challenge period), and d 14 to 28 for all treatments compared with the NMC treatment birds. Percent weight gain during the challenge period was NMC 67%, SCB dose 1 75%, SCB dose 2 78%, and VIR 81%. The percentage of NE mortality (8.75%) and lesion score (0.85) for NMC fed birds were significantly higher (P < 0.05) than all other treatments. The percent NE mortality and lesion score was for SCB dose 1 (2.5%, 0.48), SCB dose 2 (2.5%, 0.34) and VIR (3.75%, 0.57). The percent NE mortality and lesion scores for all feed additive treatments were not significantly different. This study demonstrated benefits in live performance and reduction in NE when issued Saccharomyces cerevisiae boulardii or virginiamycin in feed of broiler chickens exposed to Clostridium perfringens. Key Words: Clostridium perfringens, Saccharomyces cerevisiae boulardii, virginiamycin, necrotic enteritis, coccidiosis

122 Utilization of rye by poultry: The role of gut-liver axis on microbial ecology in the gastrointestinal tract and bacterial translocation. G. Tellez1, J. D. Latore1, H. Lester1, D. Lester1, J. Blankenship1, A. Wolfenden1, J. L. Vicente2, R. Wolfenden2, V. Kuttapan1, L. R. Bielke1, O. Faulkner1, X. Hernandez-Velasco3, E. Vicuña1, B. M. Hargis1, and M. H. Kogut1, 1University of Arkansas, Fayetteville, AR, 2Pacific Vet Group, Fayetteville, AR, 3FMVZ-UNAM, Mexico City, DF, Mexico, 4USDA-ARS, College Station, TX.

Performance of rye-fed birds can be improved markedly by dietary supplementation with exogenous xylanase. Previously, we have reported that dietary inclusion of selected direct-fed microbial (DFM) candidates that produce endogenous enzymes in NSP diets significantly reduced both viscosity and Clostridium perfringens proliferation compared with control diets without the DFM in vitro. In the present study, a starter corn-soybean-based diet (CD) was compared with a rye-soybean-based diet (RD) (n = 20). Both diets were administered ad libitum to 1-d-old pouls in 2 independent trials. At d 10, all pouls in both groups were humanely killed and liver sections were aseptically collected to determine coliform counts (cfu/g) on MacConkey agar plates. Intestinal contents from duodenum to cloaca were collected to determine viscosity. In trial 2, all pouls received an oral gavage of fluorescein isothiocyanate dextran (FITC-d; 3–5 kDa) 2.5 h before killing and blood samples were collected for appearance of circulating FITC-d. Total counts (cfu/g) of coliforms, lactic acid bacteria (LAB), or anaerobes were also determined by plating in selective media from duodenum, ileum, and ceca, respectively. In both experiments, a significant reduction (P < 0.05) in the total number of coliforms in the liver as well as intestinal viscosity was observed in the group of pouls fed CD compared with RD. In trial 2, pouls fed RD showed a significant increase in serum FITC-d; total LAB in duodenum, ileum, and ceca; total coliforms in ileum and ceca; and total anaerobes in ceca compared with pouls fed a CD. Intestinal bacterial overgrowth and bacterial translocation of gut flora via portal circulation to the liver predispose poultry to systemic bacterial infections. A better understanding of cell-specific recognition and intracellular signaling events involved in sensing gut-derived microbes will help in the development of means to achieve an optimal balance in the gut-liver axis. Studies to evaluate the possible inflammatory effects of the NSP in RD in poultry are currently being evaluated. Key Words: Bacillus, DFM, enzyme, bacterial translocation, viscosity

123 Vertical infection with Salmonella enterica var. Enteritidis and its effects on the avian embryo. R. M. Noiva*, A. C. Menezes, and M. C. Peleteiro, Interdisciplinary Research Centre on Animal Health, Faculty of Veterinary Medicine, University of Lisbon (CIISA/ FMV/ULisboa), Lisbon, Portugal.

Poultry can become infected with a variety of pathogenic bacteria that can be vertically transmitted to the progeny. Histopathological and microbiological analysis of infection-related changes in the embryo may prove to be a practical way of detecting infectious agents in samples with little to no market value, complementing the blood/serum sample analysis of the flock. With the recent programs for control of Salmonella infection in US flocks, direct microbiological egg/embryo analysis could contribute to protect both flock and public health. This study aimed to simulate vertical infection with Salmonella Enteritidis, characterizing physiological and pathological changes in chicken embryos, in response to infection. Two hundred 80 specific pathogen-free eggs were divided into 4 different groups, 2 negative controls and 2 trial groups. The first trial group was inoculated with 10^5 cfu/mL of Salmonella Enteritidis reference strain (CECT-4300) in sterile NaCl (0,9%). The second trial group was inoculated with the same strain at 10^2 cfu/mL. Each trial group was incubated concurrently with a control group (inoculated with saline). Break-outs were performed every 48 h to evaluate the effects of each manipulation on embryo development. Presence/absence of Salmonella in all groups was confirmed by conventional PCR. Statistical analysis employed the Chi-Square test and one-way ANOVA. Both treatments resulted in significantly higher mortality rates for the trial groups, ranging between 71.64% (10^2 cfu/mL; P < 0.01) and 46.67% (10^5 cfu/mL; P < 0.01) with time of death restricted to the first 7 d of incubation. Only one embryo survived as far as d 18 of incubation for the first trial group, whereas in the low-inoculum group, half of the eggs open at d 20 contained viable embryos. No macroscopic lesions (e.g., necrotic foci, hyperemia/congestion) were detected in viable inoculated embryos, except for a single case of compound malformation (multiple malformations in a single bird) observed in the low-inoculum group, supporting the theorized ability of Salmonella Enteritidis to generate asymptomatic carriers, albeit causing elevated embryo death rates. Key Words: chicken embryo, vertical infection, Salmonella Enteritidis.