

Nonruminant Nutrition: Health 1

342 Transforming coccidiosis mediated lesion score effects into estimates of performance and calorific costs in the form of ADG, FCR, malabsorption and effective caloric value throughout the broiler growth curve to 48 days of age.

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Methodologies enabling the conversion of intestinal lesion score into calorific cost estimates have been developed. Coccidiosis, the major disease challenge for broilers, reduces ADG and elevates FCR. Birds normally develop immunity during the production cycle, but uncertain timing can lead to intestinal lesion scores ranging throughout the growth curve. Vaccination at hatch speeds immunity development, reduces lesion score severity and shifts lesion scores to the early weeks. To examine the caloric cost of immunity development 2 groups of birds were reared in cocci free environments with one vaccinated at hatch (Coccivac-B) and the other maintained as naive to cocci. Birds were selected from the 2 backgrounds at 5 weekly intervals for metabolic chamber placement. The 5 challenge periods consisted of an oral dose of sterile saline or a mixture of 3 *Eimeria* species as oocysts. Metabolic costs of cocci challenge included appetite suppression, maintenance energy cost, malabsorption as excreta calorie elevation and reduced performance. Though immunity development occurring early in the production cycle, had energy costs, birds with late growth curve immunity development exhibited significantly higher costs in all categories. In this study coccidiosis mediated lesion scores 6 d post oocysts challenge at 14, 21, 28, 35, and 42 d, exhibited highly significant deleterious impact with marked elevation late in the growth curve (35, 42 d). Lesion score 1 and 2 reduced the dietary effective caloric value from an initial 3,200 kcal/kg ration by 125 and 596 kcal for 800 g broilers and by 625 and 2,277 kcal/kg for 3000g birds, respectively. Calorimetry data substantiated the lesion consequence with increased maintenance energy need, heat production and malabsorption. Timing of immunity development is critical to performance as late growth curve cocci challenges markedly exacerbated energy costs for birds lacking immunity.

Key Words: coccidiosis, immune response, energy

343 Mintrex-Zn improves tibia Zn deposition and antioxidant status of broilers under stress with coccidiosis challenge.

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An experiment was conducted to investigate the beneficial effects of the organic zinc (Mintrex-Zn) vs inorganic zinc for broilers chicks reared under stress with coccidiosis challenge. Tibia Zn, bone breaking strength, and oxidative enzymes were examined during study. A total of 480 one day-old male chicks were randomly placed into 80 cages of 6 chicks each. A corn-soybean meal diet containing Zn 29.64 mg/kg was used as a basal diet for the negative control group, supplemented with Zn at 20, 40 and 60 organic Zn per kg of diet, respectively. Treatment 2 is the positive control supplemented with reagent-grade zinc sulfate at 40 mg/kg while Mintrex-Zn (a methionine hydroxyl analog chelate) was used as an organic source for the treatment 3, 4 and 5. Half of the chicks in each treatment were inoculated by gavage with 1.5×10^4 *E. tenella* sporulated oocysts at 21 d of age. For the non-infected group, the tibia Zn deposition and bone breaking strength of chicks fed Mintrex-Zn was higher ($P < 0.05$) than those fed inorganic Zn at the same levels (40 mg/kg). Similar tendency, supplementation of Mintrex-Zn resulted in significant increase in GSH-Px activity ($P < 0.001$), and tended to

elevate ($P = 0.08$) Cu/Zn-SOD activity while LPO (lipid peroxidation) was markedly decreased ($P < 0.05$). For the infected group, tibia Zn retention, bone breaking strength of chicks fed Mintrex-Zn at 40 mg/kg were highest among the treatments ($P < 0.001$) and reached the plateau thereafter. The maximum Cu/Zn-SOD and GSH-Px activities and decreased LPO were also observed in the chicks fed diet supplemented with Mintrex-Zn vs inorganic corresponding. It can be concluded that Mintrex-Zn enhanced tibia Zn deposition and could be considered to be more protective than zinc sulfate in terms of reducing the negative effect of oxidative stress induced by coccidiosis infection.

Key Words: organic zinc, antioxidant enzymes, broilers

344 Effects of type and level of dietary fiber on digestive traits and nutrients digestibility in broilers.

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The effects of inclusion of oat hulls (OH) and sugar beet pulp (SBP) in the diet on total tract apparent of retention (TTAR) of nutrients were studied in broilers from 1 to 21 d of age. A control diet based on cooked rice that contained 3,260 kcal AME_n/kg and 1.6% crude fiber (CF) was diluted with 0, 2.5, 5.0, and 7.5% of either OH or SBP. Each treatment was replicated 6 times (a cage with 12 chicks). Digestive traits and nutrient retention were recorded at 7, 14, and 21 d of age, and jejunal histology at 14 d of age. Broilers fed additional fiber had heavier gizzards with higher digesta contents and lower pH than those fed the control diet ($P \leq 0.001$). As the level of fiber increased the relative weight of the gizzard increased linearly ($P \leq 0.001$) and gizzard pH was reduced ($P \leq 0.05$). Broilers fed OH had heavier gizzards ($P \leq 0.001$) with less digesta content ($P \leq 0.001$) and higher pH ($P \leq 0.01$) than those fed SBP. Villus height was reduced ($P \leq 0.05$) and crypt depth tended to be shorter as the level of fiber increased. Also, the inclusion of SBP but not OH, reduced villus height: crypt depth ratio linearly ($P \leq 0.05$). Fiber inclusion affected TTAR of nutrients in different manners depending on nutrient, type, and level of fiber considered. In general, the inclusion of 2.5% fiber improved nutrient digestibility with the effects being more pronounced with OH ($P \leq 0.001$ for DM, N, and AME_n). However, the inclusion of 7.5% fiber reduced nutrient digestibility ($P \leq 0.001$), especially when OH was used. We conclude that the inclusion of up to 7.5% OH or SBP increases the weight the gizzard and reduces its pH. The inclusion of 2.5% fiber improves TTAR of nutrients. However, a further increase to 7.5% has negative effects. Young chicks have a minimal requirement of at least 2.3% CF in the diet.

Key Words: fiber sources, nutrient digestibility, broiler

345 The effects of 1.2 ppm T-2 Toxin on performance, lesions, and general health of male broilers and the efficiency of an organoaluminosilicate (mycotoxin binder).

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Mycotoxin presence has become a major problem in the Mexican livestock industry; thus producers trend is towards the use of binders to alleviate its effects. T-2 toxin is a mycotoxin that affects broilers health and performance (CAST, 2003). A trial was performed to evaluate the

toxic effect of a contamination (1.2 ppm) of T-2 and the efficiency of a commercial organoaluminosilicate. Ninety Ross 308 male broilers were randomly allocated in five groups: group 1 (negative control group), group 2 positive control (1.2 ppm T-2 toxin), group 3 (1.2 ppm T-2 toxin + 1.5 kg/ton organoaluminosilicate binder), group 4 (1.2 ppm T-2 toxin + 3.0 kg/ton organoaluminosilicate binder), and group 5 (3.0 kg/ton organoaluminosilicate binder). 18 replicates with one bird each. The birds were fed their respective diets from 10 days of age, up to 39 days, date in which they were sacrificed. We recorded the individual weight of the birds at the beginning and end of the experiment. At day 39 consumption and weight gain, feed conversion and mortality were calculated. Mean weights were: Group 1: 2307.7 g (a), Group 2: 2031.9 g (b), Group 3: 2254.3 g(a), Group 4: 2234.1 g (a), Group 5: 2246.3 g (a). Lesions of the oral cavity were scored. The results shown statistical significant differences in weight gain, and numerical differences in feed intake, feed conversion and mortality. The effects of the T-2 toxin in the broilers were practically eliminated by the incorporation of any of both doses of the organoaluminosilicate in the diet. The weight difference between the control group and the intoxicated group is of 11.2%. The weight of the challenge group (organoaluminosilicate + T-2 toxin) represents a weight recovery of 83%. We observed that T-2 toxin is of dermal toxicity and that the oral lesions reduce feed intake. The organoaluminosilicate in the diet of the animals that were given T-2 toxin, reduced the negative effects caused by the aforementioned mycotoxin.

Key Words: organoaluminosilicate, T-2 Toxin, mycotoxin binder

346 Strategies to reduce preharvest *Salmonella* in organic broilers. K. G. S. Lilly*, K. R. Beaman, B. N. West, L. K. Shires, S. A. Loop, P. J. Turk, G. K. Bissonnette, and J. S. Moritz, *West Virginia University, Morgantown*.

Antibiotics are popularly used to combat bacteria, such as *Salmonella*. However, due to the concern of antibiotic resistant bacteria, organic poultry products have gained consumer interest. Outdoor rearing requirements for organic poultry could increase exposure to bacteria, including *Salmonella*. The objective of this USDA NIFSI funded project was to assess the effects of prebiotics and probiotics (Study 1) and acidifying water treatments (Study 2) on organic broiler performance and the presence of *Salmonella*. Study 1: A prebiotic (MAN), 2 probiotics (PRO1 and PRO2) and a control treatment (CON) were implemented. Study 2: Raw apple cider vinegar (RACV), organic acid blend (OA), hydrogen peroxide (H2O2) and a control treatment (CON) were incorporated into watering systems. For both studies, 300 1-d-old Cobb 500 male chicks were randomly assigned to treatment and pen. On d-21 birds were weighed and designated to one of 13 weight classes for each treatment and allocated 13 per pen within each of the 5 housing locations which included pasture access at the West Virginia University Certified Organic farm. Data collection occurred from d-21–49. For Study 1, PRO1 and MAN demonstrated the highest d-21 bird weight (BW), followed by CON and then PRO2 ($P < 0.05$). Study 1 treatments did not affect feed intake, live weight gain, feed conversion or ending BW ($P > 0.05$). For Study 2, on d-21, OA were the largest, followed by CON, H2O2 and RACV ($P < 0.05$). OA consumed more feed than H2O2 and RACV birds, but the same amount as CON. Water intake was consistent for OA, CON and RACV, while H2O2 consumed the least ($P < 0.05$). On d-49, OA had higher BW than H2O2 and RACV, but the same as CON ($P < 0.05$). RACV and CON d-49 BW were the same and H2O2 had the lowest ending BW ($P < 0.05$). For both studies, on d-29 and d-50, samples were taken to determine the presence of *Salmonella* in feed,

litter and water. An additive x location and an additive x sampling day interaction was observed for the presence of *Salmonella* ($P < 0.05$).

Key Words: antibiotic alternatives, organic broilers, *Salmonella*

347 Cecal microbial populations of young chicks fed several prebiotic-type compounds as determined by DGGE and quantitative PCR. C. M. Jacobs*, P. L. Utterback, and C. M. Parsons, *University of Illinois, Urbana*.

The objective of the current studies were to investigate the prebiotic effects of supplementing Grobiotic (GB) and DairyLac-80 (International Ingredient Corporation, St. Louis, MO), Temulose (Temple Inland, Diboll, TX), lactose, and Alternan (USDA, Peoria, IL) on cecal microbial populations in young chicks fed corn-SBM diets using DNA-based qualitative (denaturing gradient gel electrophoresis; DGGE) and quantitative (qPCR) techniques. In Experiment 1, 5% GB, 0.5% Temulose, and combinations thereof were fed for 3 or 7 d post-hatch. In Experiment 2, 5% GB, 1% lactose from DairyLac-80 or pure lactose were fed for 3, 7, or 21 d post-hatch. In Experiment 3, 1 or 2% Alternan was fed for 3, 7, or 21 d post-hatch. In Experiment 1, bacterial enumeration by qPCR did not detect any positive significant differences in bifidobacteria, lactobacilli, or *E. coli* populations when GB, Temulose, or combinations thereof were included in the diet for 3 or 7 d, but DGGE dendrograms and unrooted trees showed that replicates were clustered together by diet. In Experiment 2, at 3 and 7 d of age, there was an increase ($P < 0.10$) in bifidobacteria for all GB, DairyLac-80, and lactose treatments when compared with the basal diet treatments. At 21 d, 1% lactose decreased *E. coli* populations at every collection period. The DGGE indicated that replicates were clustered more by diet than age. In Experiment 3, the addition of Alternan had no positive effects on any selected microbial populations across all age periods. Replicates were clustered both by diet and age. When considering the effect of age for a single dietary treatment, there was a linear decrease ($P < 0.05$) for all selected microbial populations with increased age. Our results indicate that cecal microbial populations of young chicks can be affected by the addition of prebiotic-type compounds to the diet, but the changes in microbial populations as the birds age is not as clear.

Key Words: chick, denaturing gradient gel electrophoresis, polymerase chain reaction

348 Turkey response to the inclusion of a *Saccharomyces cerevisiae* fermentation product, Original XPC, in antibiotic free diets following a coccidia vaccination. D. M. Paiva*¹, C. L. Walk¹, R. Lehman¹, J. R. Sottosanti¹, C. F. Honaker¹, D. T. Moore², and A. P. McElroy¹, ¹Virginia Polytechnic Institute and State University, Blacksburg, ²Diamond V Mills, Inc., Cedar Rapids, IA.

Saccharomyces cerevisiae fermentation products are among feed additives with potential to support intestinal integrity and immune defense to improve intestinal health of commercial poultry. The objective of this study was to evaluate the effect of XPC (a commercially available fermentation product) supplementation on turkey performance to 63d during a mild intestinal challenge from a commercial live coccidia vaccine. Day old female, Hybrid Converter turkeys were obtained from a commercial hatchery, weighed and randomized (22poult/pen) into 8 treatment groups. The experiment was a 4×2 factorial design with 4 dietary treatments and 2 coccidia vaccination treatments (vaccinated and non-vaccinated). Vaccinated and non-vaccinated birds were given one of the 4 diets with different inclusion levels of XPC (no XPC = negative control; 0.0625% = 0.5X, 0.125% = 1X; 0.250 = 2X), and each dietary treatment was replicated by 18 pens (9 vaccinated and 9 non-

vaccinated). Body weight (BW) and feed intake were measured on d 0, 28, 42 and 63 and cumulatively (d0–63), and mortality was recorded daily. Adjusted feed conversion was calculated for each of these periods, corresponding to diet changes, and cumulatively. Birds fed with XPC had heavier ($P < 0.001$) BW than control fed birds at d28 and 42 and increased BW gain during pre-starter (d0–28) and starter (d28–42) feeding periods. Vaccinated birds were significantly heavier ($P < 0.004$) than non-vaccinated at d63 and had increased BW gain compared non-vaccinated birds during d42–63 ($P < 0.006$) and d0–63 ($P < 0.004$). Feed consumption was higher ($P < 0.05$) for birds fed diets containing XPC at 0.5X and 1X during d0–28. Feed conversion was only different during the d0 to 28 period with 2X inclusion of XPC resulting in the most efficient conversion. These results suggest that XPC was able to promote intestinal health and maintain turkey performance during mild challenge to the intestine from a live coccidia vaccine.

Key Words: fermentation product, coccidia vaccination, turkey

349 Effect of diet on equine gut microbiota. K. Daly*¹, C. J. Proudman¹, H. J. Flint², and S. P. Shirazi-Beechey¹, ¹University of Liverpool, Liverpool, UK, ²Rowett Institute of Nutrition and Health, Aberdeen, UK.

The horse has evolved as a highly adapted hindgut fermenter, with a voluminous large intestine (LI) containing specialized microbial populations. Dietary plant fiber is fermented by intestinal microbiota to short chain fatty acids (SCFA) notably acetate, propionate and butyrate. SCFA, once absorbed, not only provide a significant proportion of horse's energy requirements, but are also important in regulating physiological processes essential for the maintenance of LI health. Today's horse, however, is fed diets supplemented with readily digestible hydrolysable carbohydrates (hCHO), generally in the form of grain, to provide further energy for the demands of work and performance. It is proposed that when horses are introduced abruptly to diets containing high levels of hCHO, a substantial proportion of starch reaches the LI. There it is fermented to metabolites which can cause drastic alterations in intestinal pH and composition of microbiota, disposing the horse to intestinal dysfunction e.g., colic. Using 16S rRNA oligonucleotide hybridization technology, we previously characterized and identified the major bacterial groups inhabiting the LI of horses maintained on pasture forage. Aims: to determine changes in microbiota and fermentation products measured in large intestinal content of i) 12 horses fed grain based diets and euthanized for conditions other than gastrointestinal disease and ii) 12 horses suffering from simple colonic obstruction and distension (SCOD). Results: In response to grain feeding and in disease, compared with grass-fed horses, the relative abundance of saccharolytic, lactate producing bacteria increased by up to 2-fold ($P < 0.05$), with a concomitant 2–4 fold ($P < 0.01$) decrease in the relative population abundance of acid intolerant cellulolytic bacteria. Furthermore, there were significant increases in the intestinal concentration of lactic acid (up to 8-fold [$P < 0.01$]). Changes in both microbial population and fermentation products were exaggerated in horses suffering from SCOD. These alterations not only result in significant decline in SCFA, but also promote lactic acid and gas production, disposing the horse to intestinal dysfunction.

Key Words: horse, diet, gut microbiota

350 Spatial alternative splicing of Mucin 2 (*Muc2*) mRNA in chicken intestine. Z. Jiang*, C. Troche, A. C. Lossie, and T. J. Applegate, Purdue University, West Lafayette, IN.

Mucins are a large class of diverse, complex proteins that respond to their constantly changing intestinal environment by altering their

production of specific protein isoforms. The complexity and diversity of gel-forming mucin isoforms within the gastrointestinal tract are largely regulated by its primary encoding gene, Mucin 2 (*Muc2*). We hypothesized that the protein diversity was generated by alternative splicing events, particularly within different regions of the intestine. Therefore, we isolated total RNA from 4 regions of the chicken intestinal mucosa (duodenum, jejunum, ileum and cecal tonsil; $n = 4$ /each tissue) and performed RT-PCR across different domains of the *Muc2* gene on DNase treated RNA. A hypothetical chicken *Muc2* cDNA (XM_421035) localized the gene to Chr 5. Cross species comparisons indicated that the chicken gene shows 50 to 67% homology to zebrafish, cattle, mouse, chimpanzee and human. Based on this sequence, we designed 13 sets of primers to clone the chicken *Muc2* gene. These amplicons spanned bases 25–7961 of the 7968 bp predicted cDNA. Sequence data from these clones indicated a match with the predicted *Muc2* cDNA. PCR analysis demonstrated that all 13 amplicons were detected across the 4 intestinal tissues. Interestingly, primers that span exons 5 to 9 detected variably sized products. Ileal and cecal tonsil samples produced slightly smaller cDNA amplicons than duodenal and jejunal tissues. Further sequencing and correlation with *Muc2* protein would help understand the role of these tissue-specific alternatively spliced products.

Key Words: chicken, intestine, mucin

351 Differences in carbohydrate composition of barley varieties influence Salmonella transmission among pen mate weaned piglets. J. Bindelle¹, R. Pieper², J. K. Marshall³, G. Malik*³, B. R. Rossnagel³, P. Leterme⁴, and A. G. Van Kessel³, ¹University of Liege, Gembloux Agro-Bio Tech., Liege, Wallonia, Belgium, ²Freie Universitat, Berlin, Germany, ³University of Saskatchewan, Saskatoon, SK, Canada, ⁴Prairie Swine Centre Inc., Saskatoon, SK, Canada.

Indigestible carbohydrate (CHO) composition can vary markedly between barley varieties. They induce changes in intestinal ecophysiology and enhance growth of health-promoting bacteria. An experiment was undertaken to assess whether these changes could influence *Salmonella typhimurium* (ST) infection in pigs and transmission between penmates. A challenge study was undertaken using 84 recently weaned piglets divided in 12 pens, and fed one of the 4 experimental diets (3 pens/diet), according to the barley variety. Three hullless and one hulled varieties were chosen according to their differing CHO composition (amylose/amylopectin, β -glucan, and insoluble non-starch polysaccharides). After 14 d of adaptation, 2 pigs per pen (Trojan pigs, TrojP) were orally infected (8.0 log cfu/animal) with a low virulent, nalidixic acid and novobiocin resistant ST strain. The other animals were considered as Contact pigs (ConP) to assess ST transmission. Over 5 d following inoculation, pigs were monitored for detection of ST in the feces using plate counts. On d 6, 2 TrojP and 2 ConP per group were killed and intestinal samples as well as organ samples (liver, spleen, and lymph nodes) were analyzed for ST. The results showed that in TrojP, the cereal variety had no influence on ST fecal shedding over time and gastrointestinal tract (GIT) colonization. All pigs were positively tested for ST. Translocation of ST to lymph nodes was observed frequently but not to other organs. In ConP, compared with hulled barley, hullless barleys reduced the number of animals shedding ST ($P < 0.05$ for d 2) and the number of ST (cfu/g) in cecum on d 6 ($P < 0.01$). Although hullless barleys did not protect against colonization when directly challenged at a high oral dose, these barleys may be useful to reduce natural ST transmission among penmates.

Key Words: barley, pigs, Salmonella

352 Histomorphology and small intestinal sodium-dependent glucose transporter 1 gene expression in piglets fed phytic acid and phytase-supplemented diets. T. A. Woyengo*¹, J. C. Rodriguez-Lecompte¹, O. Adeola², and C. M. Nyachoti¹, ¹University of Manitoba, Winnipeg, Manitoba, Canada, ²Purdue University, West Lafayette, IN.

An experiment was conducted to determine the effect of dietary phytic acid (PA) and phytase supplementation on small intestinal histomorphology and sodium-dependent glucose transporter 1 (SGLT1) gene expression in piglets. Twenty-four piglets with an average initial BW of 7.60 ± 0.73 kg (mean \pm SD) were randomly assigned to 3 experimental diets to give 8 piglets per diet. The diets were a casein-cornstarch-based diet that was supplemented with 0, 2% PA (as sodium phytate), or 2% PA plus an *Escherichia coli*-derived phytase at 500 FTU/kg. The basal diet was formulated to meet NRC (1998) energy, amino acids, minerals and vitamins requirements for piglets. After 10 d of feeding, the piglets were killed for determining histomorphology and small intestinal SGLT1 gene expression. Phytic acid supplementation did not affect ($P > 0.05$) villous height (VH) and VH to crypt depth (CD) ratio, but decreased ($P < 0.05$) CD in the jejunum. Phytase supplementation did not affect ($P > 0.05$) VH, CD and VH to CD ratio. Phytic acid supplementation reduced SGLT1 gene expression in duodenum, jejunum and ileum by 1.1, 5.4 and 2.4 folds, respectively. Phytase supplementation increased SGLT1 gene expression in jejunum by 2.6 folds, but reduced the expression of the same in the duodenum and ileum by 2.0 and 4.0 folds, respectively. In conclusion, PA reduced the CD in the jejunum and the SGLT1 gene expression in the duodenum, jejunum and ileum, whereas phytase supplementation increased the expression of the SGLT1 in the jejunum. The reduced SGLT1 gene expression by PA implies that the latter reduces nutrient utilization in pigs partly through reduced expression of the SGLT1 that is involved in glucose and sodium absorption. The increased expression of the SGLT1 in jejunum by phytase supplementation implies that the latter alleviates the negative effects of PA partly through increased expression of the SGLT1.

Key Words: phytic acid, phytase, piglets

353 Effects of essential oils on *Clostridium perfringens* infections in broilers. T. Steiner*¹, F. van Immerseel², and R. Ducatelle², ¹BIOMIN Holding GmbH, Herzogenburg, Austria, ²Department of Pathology, Bacteriology and Avian Diseases, Ghent University, Merelbeke, Belgium.

Clostridium perfringens-induced necrotic enteritis (NE) has become a major problem in broiler flocks. Application of essential oils in the drinking water was evaluated as potential alternative to reduce the incidence of NE. Mixed-sex Ross broilers were assigned to 3 dietary treatments (cages) with 30 birds per treatment: (1) Uninfected, untreated (Negative Control, NC), (2) Infected, untreated (Positive Control, PC), (3) PC + liquid phyto-genic additive containing essential oils from oregano, anise, and citrus peel (Biomin P.E.P. sol) applied in the drinking water (60 mL/1000 L) from day 15-25. Birds were fed diets based on wheat, rye and soybean meal. From day 17 onwards, the diets contained 30% fishmeal as protein source. A Gumboro vaccine (Nobilis Gumboro D78, Intervet, Mechelen, Belgium) was applied in the drinking water at day 16 in all treatments. Furthermore, Treatments 2 and 3 were challenged orally three times a day with 4×10^8 CFU of *C. perfringens* strain 56 at days 17, 18, 19 and 20. At day 18 all birds were orally inoculated with a ten-fold dose of Paracox-5 (Schering-Plough Animal Health, Brussels, Belgium). At days 22, 23 and 24, 10 animals of each group were euthanized and intestinal lesions in the duodenum, jejunum and ileum were evaluated using a lesion score (ranging from 0, no gross lesions, to 6, severe necrosis typical of field cases). Lesion scores of 2 or more were classified as NE-positive. The data were analyzed with SPSS 16 software using the multivariate logistic regression method to compare the number of NE-positive animals in the test group with the number of NE-positive animals in the Positive Control group. Cage was the experimental unit. Birds in the NC had no intestinal lesions, whereas the PC had the highest percentage (58.6%) of birds with lesions. In comparison with the PC, the percentage of birds with lesions was reduced ($P < 0.05$) in Treatment 3 (27.6%). Lesions were found in the duodenum and jejunum, but not in the ileum, of birds in Treatments 2 and 3. In conclusion, application of essential oils in the drinking water has potential to prevent, at least in part, the development of NE infections in broilers.

Key Words: broilers, *Clostridium perfringens*, essential oils