378 Digestible lysine requirements for tom turkeys from six to twelve weeks of age. K. A. Baker*, D. T. Moore*, and J. D. Firman, 1 University of Missouri-Columbia.

Two experiments were conducted to determine the digestible lysine requirements of Nichols White toms during the 6-9 week and 9-12 week growth periods. For the 6-9 week period, 576 six week old male toms were weighed and allotted to 48 pens. For the 9-12 week period, 432 nine week old toms were split into 48 pens. Eight levels of lysine were tested and a positive control was included for both trial periods. Digestible lysine levels tested ranged from .88% to 1.22% during the first trial period and from .68% to 1.00% for the 12 week period. Treatments were made by titrating lysine into a low protein diet which was fortified with synthetic amino acids. The positive control was a typical corn and SBM diet based on NRC (1994) recommendations for the appropriate period. Bodyweight gain and feed conversion responses were measured at the end of each trial period. Lysine requirements were determined using the normal broken line model. The requirement for optimum bodyweight gain during the 6-9 week growth period was found to be 1.00% on a digestible basis. For optimum feed conversion it was found to be 1.11% for the 9-12 week period the requirement based on bodyweight gain was found to be 0.87% The requirement based on feed conversion was determined to be 0.82% during the 9-12 week period.

**Key Words:** Turkey, Lysine, Digestible amino acids

379 Digestible methionine requirements for male turkeys from 0-6 weeks of age. D. T. Moore*, J. D. Firman, and K. A. Baker, University of Missouri-Columbia.

Floor pen trials were conducted to determine the digestible methionine requirement of male turkeys for the production periods of 0-3 weeks and 3-6 weeks. The experiments were completed using 48 pens allowing 8 treatments of 6 replicate pens using a randomized block design. For the 0-3 week period 768 seven-day-old toms were sorted by weight and assigned a treatment. Digestible methionine ranges from 0.60% to 1.00% . These levels were obtained by titrating synthetic methionine into a low protein diet. Other synthetic amino acids were also added to the low protein diet in order to maintain NRC (1994) amino acid levels. For the 3-6 week period the same procedure was used with 480 21-day-old poult. The titrated levels of methionine ranged from 0.57% to 0.95% . The positive control for each period was a standard corn and SBM diet based on NRC (1994) recommendations. Growth parameters measured for each trial period were body weight gain and feed conversion. The data were analyzed by analysis of variance followed by breakpoint analysis. Digestible methionine requirements for the 0-3 week growth period are 0.83% and 0.82% for body weight gain and feed conversion, respectively. For the 3-6 week growth period a preliminary study indicated the digestible methionine requirements to be 0.79% and 0.77% for body weight gain and feed conversion, respectively.

**Key Words:** Methionine, Turkey, Digestibility, Amino acids


A total of 720 Ross × Ross 308 male broilers were fed six concentrations of threonine ranging from 0.50% to 0.80% during 42 to 56 days of age. Birds were given common starter and grower feeds before receiving a corn-peanut meal diet formulated to contain 0.50% total threonine with 0.66% increments of supplemental L-threonine. Treatments were made by titrating threonine into a low protein diet which was fortified with synthetic amino acids. The positive control was a typical corn and SBM diet based on NRC (1994) recommendations for the appropriate period. Digestible methionine requirements were determined using the normal broken line model. The requirement for optimum bodyweight gain during the 6-9 week growth period was found to be 1.09% on a digestible basis. For optimum feed conversion it was found to be 1.11% for the 9-12 week period the requirement based on bodyweight gain was found to be 0.87% . The requirement based on feed conversion was determined to be 0.82% during the 9-12 week period.

**Key Words:** Broiler, Threonine, Fillet

381 Effect of Dietary Protein Level on Broiler Immunity, Bone Strength, and Gut Strength and Elasticity. A. Mireles, Jr.*, and S. Kim*, 1 Foster Farms Feed Research Department.

The effects of 5 dietary protein levels (20, 18, 16, 14, and 12%) on broiler weight gain, feed conversion, infectious bursal disease (IBD) and bronchitis (IBV) titers, feed intake response due to Salmonella typhimurium lipopolysaccharide (LPS) injection, tibia bone and intestinal strength and elasticity were evaluated. As expected, 46 day weight gain decreased with decreasing protein levels (2.34, 2.20, 2.08, 1.75, and 1.52 Kgs/bird respectively). Similarly, feed conversion became worse as protein levels were increased (1.96, 2.05, 2.06, 2.46, and 2.72). 20 cockerels per treatment were challenged IP at 38 days with 100 micrograms of LPS/100 gms body weight. Body temperature due to LPS increased 280 minutes post-injection as the protein level decreased (+0.03, +0.03, +0.26, +0.37, and +0.55 degrees F). IBD titers increased as protein levels decreased (2630, 3055, 3506, 3528, 3472). IBV titers tended to decrease as protein levels decreased (7405, 7514, 3322, 3785, 4220). Tibia bone strength at 45 days decreased as protein levels decreased (42.7, 43.4, 39.9, 33.7, and 25.9 Kgs). Similarly, bone elasticity decreased as protein levels decreased (40.4, 41.1, 40.2, 35.7, 33.6 mins). Gut strength (363, 304, 292, 263, 255 gms) and gut elasticity (377, 319, 32.0, 29.0, 22.6 mins) decreased with decreasing protein levels. Results suggest increasing dietary protein levels decrease an acute phase immune response and increase bone strength and intestinal integrity.

**Key Words:** Dietary Protein Immunomodulation, Bone Strength, Intestinal Integrity, Acute Phase response, Broiler research

382 The Threonine Requirement of Two Broiler Genotypes: Classic and High-Yield. A. P. Rosa*, G. M. Pesti2, H. M. Edwards, Jr.2, and R. I. Bakalli. 2 Department of Poultry Science, The University of Georgia, 1 Universidade Federal de Santa Maria, RS and CAPES Foundation (Brazil).

The purpose of this experiment was to evaluate the performance of two broiler genotypes fed diets with six levels of supplemental L-Threonine. A 6x2 factorial design was conducted with six levels of THR (0.63, 0.67, 0.71, 0.75, 0.79 and 0.83 % of the diet) and two broiler genotypes (Arbor Acres Classic and High Yield) from 1 to 18 days of age in battery brooders. There were four replicate pens of eight male birds per treatment. The basal diet was based on corn, peanut meal, poultry by-product meal, poultry fat, DL-Methionine and L-Lysine (23% of crude protein and 3.2 kcal/g of metabolizable energy). At 18 days of age three birds by replicate were killed and livers, breast muscles and fat pads were taken. For body weight gain (0-9 and 9-18 days), there was a significant interaction between strain and THR level. The high yield strain broilers grew significantly better at the lowest THR level (302 ± 9 vs. 356 ± 5), but performance was similar at the higher THR levels (453 ± 4 vs. 470 ± 4; P<0.018). Feed conversion was affected by THR level but not by strain. Percentage liver weight, % fat pad and level of liver fat were not affected by strain. The levels of THR did not affect % fat pad or liver fat (P>0.0005) but % liver weight was increased in chicks fed 0.63 and 0.67 % THR. The broken-line linear model was used to estimate the chicks THR requirement [response=max+r(c*x)-x; where max=plateau, r=rate constant, c=requ requirement, x=level, and l=1 when x < req, otherwise l=0]. The THR requirement of the classic strain was 0.69 ± 0.01 for gain and 0.68 ± 0.01 for feed conversion. The THR requirement of the high yield strain was 0.68 ± 0.01 for gain and 0.69 ± 0.01 for feed conversion.

**Key Words:** Threonine, Peanut meal, Broiler


Some authors suggest that current dietary protein levels recommended for post-hatched chicks are greater than required. A trial was conducted to study the effect of two dietary protein levels for post-hatched broilers.
on performance and gastrointestinal tract (GIT) development. A total of 180 one-d-old chicks were allocated at random to two treatments differing in their crude protein content: 10.1% (LP) and 21.9% (HP) fed from 0 to 6d. From 6 to 21d, all chicks received the HP diet and from 21 to 42d, a commercial finishing diet. Each treatment was replicated 6 times (15 chicks per cage). At 2, 4, 6, 11, 14, and 21d, one chick per pen was randomly selected to determine the relative weight of liver, pancreas, small intestine, proventriculus, and gizzard respect to BW. Feeding the LP diet during the first 6d of life impaired performance throughout the trial. A significant difference was observed in ADG from 0 to 21d, (25.1 vs 30.1 g/d for LP and HP diets, respectively; P<0.01) and from 21 to 42d, (63.6 vs 70.2 g/d, respectively; P<0.13). The impairment in ADG by the LP diet was partially explained by a reduction of feed intake from 0 to 21d (40.3 vs 47.2 g/d for LP and HP diets, respectively; P<0.01), and from 21 to 42d (115.0 vs 124.9 g/d; P<0.05). Feed to gain ratio was not significantly affected by dietary protein level (P>0.05). At 6d of age chicks receiving the LP diet had a smaller pancreas, small intestine, and proventriculus (P<0.05) relative to BW than broilers fed the HP diet. However, relative weights of other organs such as liver and gizzard were not affected by dietary protein level (P>0.05). After the chicks of both experimental treatments were fed the HP diet, the relative weight of the organs of GIT tended to be equal. In conclusion, the feeding of LP diets from 0 to 6d post-hatch impaired the development of some GIT organs that led to an impairment of performance even at slaughter weight.

**Key Words:** Post-hatching, Protein level, GIT development, Broilers

### 384 Relative Bioavailability of Two Labile Methyl Sources Methionine and Betaine. M. N. Garcia1, T. P. Chendrimada2, G. M. Pesti2, and R. I. Bakalli2, 1Universidade Estadual Paulista/Brazil, 2Department of Poultry Science, The University of Georgia.

Two experiments were conducted with commercial strain chickens in battery brooders to determine the relative bioavailability of the labile methyl sources methionine and betaine. The basal corn-soybean meal diet contained 1806 and 1969 mg/kg choline in Experiments 1 and 2, respectively, and 0.74% methionine+cystine. In Experiment 1 (female broilers for 21 days), there were 6 levels of methionine+cystine (0.74; 0.82; 0.90; 1.06; 1.22%) and 2 levels of betaine (0 and 628 mg/kg); a 6x2 factorial design. In Experiment 2 (male broilers for 20 days), the basal diet was supplemented with 0, 400, 800, 1200, 1600 or 2000 mg/kg methionine or 0, 314; 628; 942; 1256 or 1570 mg/kg betaine. In both Experiments 1 and 2, there were 4 replicate pens per treatment with 8 chicks each, and eight replicate pens for the control group in Experiment 2. In Experiment 1, the chicks methionine requirements with either 0 or 682 mg/kg levels of betaine was determined using the broken-line linear statistical model [response= max+rc(1-exp(-kx))] where max=plateau, r=rate constant, k=rate requirement, and I=1 when x less than req, otherwise I=0]. The methionine + cystine requirement for body gain was 0.85+0.02% with 0 mg/kg betaine (r2=0.99), and 0.81+0.02% with 682 mg/kg betaine (r2=0.99). For feed conversion ratio, the methionine+cystine requirement was 0.89+0.04% (r2=0.99) and 0.85+0.03% (r2=0.99) for 0 and 682 mg/kg betaine, respectively. The relative bioavailabilities of betaine compared to DL-methionine were 64% and 67% for body gain and feed conversion ratio, respectively (molar basis). In Experiment 2, the slopes for betaine and methionine were significantly different for body weight gain (P<0.01), and feed conversion ratio (P<0.0197). The slope ratio assays indicated 50% and 56% relative bioavailabilities for betaine (molar basis) for body weight gain and feed conversion ratio, respectively, when compared to the standard source of DL-methionine.

**Key Words:** Methionine, Betaine, Bioavailability, Body gain, Feed conversion

### 385 Comparative effects of growth enhancers in withdrawal rations of different energy or methionine concentrations. K. W. Bafundo* and H. M. Cervantes, Pfizer Animal Health, Exton, PA.

Two floor pen studies were conducted to evaluate the effects of four programs in withdrawal rations of different energy or methionine concentrations on performance and processing parameters in broilers. The experiments were designed with the cooperation of a major integrator, whose dietary formulas and feeding programs were used. Straight run, Avian X Cobb broilers were fed starter and grower feeds containing only an anticoccidial and roxarsone. The withdrawal rations were fed from days 32 through 54. In Experiment 1, birds received energy adequate (3240 Kcal ME/kg) or energy marginal (3185 Kcal ME/kg) withdrawal rations containing no growth enhancer (CON), virginiamycin (VM) 11 ppm, bacitracin methylene disalicylate (BMD) 27.5 ppm, or bambermycin (FLV) 2.2 ppm. In Experiment 2, the same withdrawal programs were administered in rations containing different methionine levels (100% and 90% of the NRC requirement) but of equal energy content. Thus, a 4 x 2 factorial design was employed in each test and treatments were replicated eight times. The results of Experiment 1 showed no differences in body weight at the end of the study. Energy content of the diet and VM produced significant main effects in adjusted feed conversion. No other programs produced significant main effects. When individual treatment comparisons were made, VM improved feed conversion compared to CON and BMD programs in energy adequate rations and to BMD and FLV energy marginal feeds (P<0.05). When breast yield was evaluated, VM produced the largest response of any growth enhancer regardless of energy content; individual comparisons revealed significant differences between VM and CON, and VM and BMD in energy adequate rations, and VM and FLV in energy marginal diets. In Experiment 2, higher methionine levels were found to improve breast yield (main effect P<0.001). VM significantly improved yield over all treatments in methionine adequate rations, and over BMD and FLV in methionine marginal feeds.

**Key Words:** energy, methionine, growth enhancer, performance, yield

### 386 The effect of dietary lysine level and TSAA:lysine ratio on egg production parameters and egg yield. C. Novak1, H. Yakout1, and S. Scheidecker1, 1Dept. of Animal Sciences, University of Nebraska.

A factorial arrangement of treatments applying two lysine levels (800 and 900 mg/hen/day) and four TSAA:lysine ratios (.71, .81, .91 and 1.01) for a total of 8 treatments was fed to Dekalb Delta hens from 23 to 66 wks of age. Each diet was replicated eight times with 5 hens per replicate pen. A phase feeding regimen was used which lowered the lysine levels to 700 and 800 mg/hen/day at 46 wks of age. Diets were formulated according to breeder recommendations utilizing the Degussa prediction model for available amino acids. Feed consumption (FC) and egg production (EP) were recorded daily while egg weights (EW) were recorded weekly. Hens were weighed monthly while egg quality measurements were obtained biweekly for breakouts and specific gravity. Overall EP and FC were non significant during the experiment. Overall avg. EP was 82.1, 84.8, 84.4, 83.2% for ratios .71, .81, .91, 1.01, respectively. Overall hen weights showed a significant (P<0.02) increase with weights of 1.53 and 1.57 Kg/bird for low and high lysine intakes respectively. EW were significantly increased during the second phase (P≤0.0005) and overall (P≤0.007) with increasing lysine intake. Overall EW were 59.0 and 60.3 g for low and high lysine intake, respectively. Likewise, egg mass increased significantly (P≤0.03) with increasing lysine. Overall albumen % revealed a significant (P<0.04) linear decrease with increase in TSAA: Lysine ratio and significant (P<0.02) increase with increasing lysine intake during phase I. Yolk % displayed the opposite effect of albumen with a significant (P<0.03) linear increase in yolk % with increase in TSAA: Lysine ratio. Overall, yolk % was also (P<0.05) decreased with an increase in lysine intake. Percent yolk solids revealed a significant (P<0.01) linear increase with increasing TSAA: Lysine ratio while % albumen solids were significantly (P<0.04) increased with increasing lysine intake. Percent shell revealed a lysine x ratio interaction during phase I, while specific gravity was significantly (P<0.01) affected by ratio during phase II. The results of the present study reveal significant improvements in hen weights, egg weight and albumen solids with higher lysine intakes. Furthermore, the level of lysine and TSAA:Lysine ratio are important elements when optimizing egg component yield.

**Key Words:** Lysine, TSAA:Lysine, Egg weight, Albumen, Yolk

### 387 Influence of supplemental lysine on egg size and production of hens fed diets formulated based on lysine. S. Sohail*, M. Bryant, and D. Roland, Auburn University, Auburn, Alabama, U.S.A.

Previous studies have indicated that hens fed diets formulated based on lys produced more profits than hens fed diets formulated based on protein. Although, lys-based diets produced more profits, egg production (EP) and egg weight (EW) were inferior to hens fed diets formulated based on protein. It was hypothesized that hen’s need for amino acids

---

**Key Words:** energy, methionine, growth enhancer, performance, yield
may be higher. An experiment was conducted as a 3 × 5 factorial to determine if increasing dietary lys in diets formulated based on lys improves EP and EW. Three sets of diets were formulated. First and second sets were formulated based on protein [met + Lys to lys ratio (M+C/L=77)] and lys (M+C/L=83) respectively. The third set was created by supplementing synthetic lys to diets formulated based on lys (M+C/L=77). Each set contained five protein levels with similar M+C/L ratios. Hylene W36 hens (n=1,920; 21 wk of age) were randomly assigned to the 15 dietary treatments. Feed consumption (FC), EP, EW and egg specific gravity were measured during the 16 wk study. Average FC was not influenced by method of formulation or protein level. However, towards the end of the study (wk 16), FC of hens fed diets formulated based on lys was significantly higher than hens fed diets based on protein. Hens of each set averaged 4.3 kcal/ME/egg. Average EP was significantly higher in diets formulated based on protein vs lys. However, adding extra synthetic lys to diets formulated based on lys increased EP, and there was no difference in EP of hens fed diets formulated based on protein vs lys with supplemental lys. Supplemental lys did not improve EW, and hens fed diets formulated based on protein produced heavier eggs. These results suggest that diets formulated based on lys, to supply a M+C/L of 83, are deficient in lysine.

Key Words: Egg weight, Lysine, TSAA

388 Interaction effects of lysine and TSAA on egg production parameters and egg components in laying hens. H. M. Yakout1, C. L. Novak, S. E. Scheider, and M. Elliot2, 1Animal Science Dept., University of Nebraska, 2Degussa Corp., Kennesaw, GA.

A 2 × 4 factorial design was implemented to study the interaction effects of lysine and TSAA in Dekalb Delta hens. Two levels of lysine: 800 and 900 mg from 23-46 wks and 700 and 800 mg from 46-66 wks and four levels of TSAA (490, 570, 650 or 730 mg/d) were fed to 8 replicate pens with 5 hens per pen. Feed intake (FI) and egg production (EP) were recorded daily. Egg weight was measured weekly. Egg components, specific gravity and haugh units were measured biweekly. Hens were weighed monthly. During phase I, EP increased as TSAA increased 86.0, 86.8, 88.6 and 88.5% at 490, 570, 650 and 730 mg/d. TSAA and 87.2 and 87.8% for 700 and 800 mg/d. lysine. Neither lysine or TSAA intake affected FI. Egg components showed a significant treatment effect with percent yolk decreasing as lysine (p≤0.001) increased and increased at high TSAA (p≤0.02) (25.9, 25.4, 26.3 and 26.4% for 490, 570, 650 and 730 mg/d. TSAA). Feed efficiency improved significantly (p≤0.02) by increasing TSAA level. In phase II, Dietary treatments did not significantly affect EP (86.7, 87.3, 89.3 and 89.2%) for TSAA at 490, 570, 650 and 730 mg/d.) and 87.8 and 88.5% for lysine intakes of 700 or 800 mg/d, respectively. Percent yolk showed the same significant main effects for both lysine (p≤0.002) and TSAA (p≤0.05) as reported in phase I. Feed efficiency improved significantly (p≤0.08) by increasing TSAA level. Overall, increasing lysine level significantly increased egg weight (p≤0.05). Egg mass, hen weight, percent albumen, specific gravity and haugh units were not affected by dietary treatments of lysine or TSAA.

Key Words: Lysine, TSAA, Egg production, Egg components

389 Effect of Conjugated Linoleic Acid (CLA) on the Composition of Egg Yolk Lipids. M. Du*, D. U. Ahn, and J. L. Sell, Department of Animal Science, Iowa State University, Ames, IA.

Conjugated linoleic acid (CLA) has been suggested to have anticarcinogenic and antiatherosclerotic effect to animal. Dietary CLA increases CLA content in eggs and such eggs could be a valuable CLA source for human. However, the metabolism of dietary CLA and the incorporation of CLA into different classes of lipids are not known. The objective of this study was to determine the deposition of CLA isomers in different classes of egg yolk lipids produced by hens fed CLA. Forty eight, 27-week-old White Leghorn hens were assigned randomly to four diets containing 0, 1.25, 2.5, or 5.0% conjugated linoleic acid (CLA). Hens were fed the CLA diets for two weeks before collecting eggs for the study. Classes of egg yolk lipids were separated, and fatty acid concentration in total lipid, triglyceride (TG), phosphatidylethanolamine (PE), and phosphatidylcholine (PC) were analyzed to determine the incorporation of dietary CLA isomers to different classes of egg yolk lipids. The amounts of CLA incorporated into lipid, PC, PE, and TG of egg yolk were proportional to the levels of CLA in the diet. However, more CLA was incorporated in TG than in PE. The incorporation rates of different CLA isomers into different classes of lipids were also significantly different: cis-9, trans-11 and cis-10, trans-12 CLA were deposited more in TG, but cis-11, trans-13 CLA deposition in TG was significantly less. There were large differences in the concentrations of cis-8, trans-10 CLA in PC and PE. The inclusion of CLA into the diet influenced the metabolism of polyunsaturated fatty acids. The contents of arachidonic, linoleic, and linolenic acids were decreased as dietary CLA increased. Three isomers of hexadesacaidoic acid were found in egg yolk lipids from hens fed 5% dietary CLA. The detection of hexadesacaidoic acid isomers in lipid indicates that more than 10% of total energy source after the first round of β-oxidation may be less favorable than that of linoleic acid.

Key Words: Conjugated Linoleic Acid, Egg Yolk, Fatty Acid Composition, Lipid Classes, Hexadesacaidoic Acid

Wednesday, AM, Arkansas Ballroom D. PHYSIOLOGY

390 Effects of antibiotics used in the poultry industry on in vitro cartilage degradation. T. L. Peters*, R. M. Fulton3, and M. W. Orth3, 1Department of Animal Science, 2College of Veterinary Medicine, Michigan State University, East Lansing, MI 48824.

Antibiotics are used in the livestock industry not only to treat disease but also to promote growth and increase feed efficiency in less than ideal environmental conditions. However, certain antibiotics recently have been shown to adversely affect bone formation and cartilage metabolism in dogs, rats, and humans. The purpose of this study was to determine the effects of antibiotics commonly used in the broiler and turkey industry on cartilage degradation in vitro. Ten antibiotics were studied using an avian explant culture system: doxycycline, oxytetracycline, lincomycin, tylosin tartrate, gentamicin, erythromycin, neomycin sulfate, salinomycin, enroflaxacin (Baytril®), and ceftiofur (Naxcel®). Embryonic chick tibiae were isolated at d 12 and placed in 24 well culture plates (3 per well) in modified D-MEM/F-12 media containing supplemental amino acids, IFG-1 (1 ng/ml), PFG (100 ng/ml), and ascorbic acid (50 µg/ml). Lipopolysaccharide (10 µg/ml) and 5% chicken serum were also added to induce cartilage degradation in vitro. Various concentrations of the antibiotics (1 µg/ml to 400 µg/ml) were added to duplicate wells at the start of each experiment. Conditioned media (CM) was replaced every 2 days or until the cartilage in the tibiae was degraded and stored at 4°C until analyzed. Proteoglycan and nitric oxide concentrations in CM were measured as indicators of cartilage degradation. Doxycycline and oxytetracycline inhibited proteoglycan degradation and nitric oxide production at concentrations greater than 50 µg/ml. Enroflaxacin at 100, 200, and 400 µg/ml and ceftiofur at 200 and 400 µg/ml inhibited proteoglycan degradation and nitric oxide production. Salinomycin at concentrations greater than 10 µg/ml had the same inhibitory effect; however, at 1 µg/ml salinomycin increased the rate of cartilage degradation relative to the control. Lincomycin, tylosin tartrate, gentamicin, erythromycin, and neomycin sulfate did not inhibit degradation at any concentration tested. These results show that some of the antibiotics used in the poultry industry inhibit in vitro cartilage degradation. Future research will determine whether these antibiotics will inhibit joint cartilage degradation in vivo.

Key Words: Antibiotics, Cartilage, Degradation


Recently, hepatic export of glutathione (GSH), an important endogenous antioxidant, was documented in broilers (Wang et al., 1998 Poultry Sci. 77:1556-64). Norepinephrine (NE) is known to stimulate GSH release from perfused rat liver (Cuxac and Graf, 1985; Biochem J. 226:545-549). However, the effect of NE on hepatic GSH release has not been reported in part because of the difficulty in obtaining blood from the hepatic vein. The purpose of this study was to determine the effect of NE on plasma GSH levels in the hepatic vein (HV) and hepatic portal vein (PV) in anesthetized SCWL males. The birds (1.6-2.1 kg BW) were implanted with cannulae in the HV and PV for blood sampling and for monitoring pre- and post-hepatic blood pressures. A second cannula in the PV was