

975 Effect of intake level on the body composition and net energy requirement of Nellore steers and bulls for maintenance and growth. L.O. Tedeschi^{*1}, D.G. Fox¹, C. Boin², P.R. Leme³, and G.F. Alleoni⁴, ¹Cornell University, Ithaca, NY, USA, ²ESALQ-USP, Piracicaba, SP, Brazil, ³FZEA-USP, Pirassununga, SP, Brazil, ⁴Instituto de Zootecnia, Nova Odessa, SP, Brazil.

Three comparative slaughter experiments with individually fed Nellore bulls (31 animals) and steers (66 animals) were used to determine their NEm and NEg and the effect of level of intake on their composition of gain. Bulls (experiment 1) were divided into two intake levels (60 g DM/kg^{0.75} of shrunk body weight (SBW) and ad libitum of a diet containing 2.3 Mcal ME/kg) and three slaughter groups, which were based on days on treatment (100, 150, and 190 days, and 130, 180, and 200 days, respectively for older and younger animal subgroups). For experiments 2 and 3, steers were allocated to three intake levels (55 and 70 g DM/kg^{0.75} SBW, and ad libitum of a diet containing 2.2 Mcal ME/kg). In both trials, three slaughter groups within each intake level were set as when animals of the ad libitum treatment reached 400, 440, and 480 kg SBW on average for the first, second, and third group, respectively. For all experiments, initial body composition was determined with equations developed from a base line slaughter group, using SBW, empty body weight (EBW), fat (EBF), and protein (EBP) as variables. For bulls, there were no differences ($P > 0.05$) between treatments in EBW percentage of protein and water, and fat and protein in the gain (FIG and PIG, respectively). In contrast, in steers level of intake affected EBW percentage of protein and fat ($P < 0.05$), but FIG and PIG were not different ($P > 0.05$). A nonlinear equation with the pooled data was developed to predict retained energy (RE) using maturity degree (u = actual/mature weight, which was estimated to be 350 and 550 kg of SBW at 25% EBF for steers and bulls, respectively); $RE = 0.00949 \cdot EWG^{0.9425} \cdot EBW^{exp(0.0924 \cdot u)}$. The NEm was similar for bulls and steers, and averaged 76 kcal/kg^{0.75} EBW. However, the efficiency of conversion of metabolizable to NEm was greater for steers than bulls (70.6 and 65.2%, respectively), indicating that bulls had an 8.6% greater ME requirement for maintenance than steers ($P < 0.05$). Our analyses do not support the hypothesis that Nellore, a *Bos indicus* species, has a lower net energy requirement for maintenance than *Bos taurus* breeds.

Key Words: body composition, net energy requirement, Nellore

PSA Pathology: Session II

977 Pathogenesis of ascites syndrome in broiler chicken in relation to combined E. coli and infectious bronchitis virus (IBV) infection. M.S. Youssef^{*}, A.H. Bayoumi, A.Z. Mahmoud, S. Mousa, and M. Mubarak, *Veterinary Medicine, Assiut University, Assiut, Egypt.*

Forty white leghorn chicks (one day old and specific pathogen free) were used in this study. Chicks were inoculated via nares with 0.1 ml E. coli (O : 115 serotype O) at the titre of 106.7 colony forming units/ml, and 0.1 ml IBV (Massachusetts serotype M41) at the titre of 105.5 ciliostatic dose 50 (CD 50). The experimental period was 7 weeks. The incidence of ascites was 20%. Tissues from inoculated birds were examined using light and electron microscopes. Immunohistochemistry was also conducted to detect IBV antigen in pulmonary tissue of inoculated birds. Pulmonary lesions were fibrinopurulent pneumonia at early stage followed by late granulomatous reaction. It was concluded that the development of ascites in IBV-E. coli infected birds is attributed to the induced pulmonary lesions which led to a state of pulmonary hypertension.

Key Words: Ascites, broiler chickens, E. coli, IBV

978 Clinicopathological studies on ascites syndrome in broiler chickens with special reference to the role of hypoxia. A.Z. Mahmoud^{*}, A.H. Bayoumi, S. Mousa, M.S. Youssef, and M. Mubarak, *Veterinary Medicine, Assiut Univ., Assiut, Egypt.*

Forty-nine ascitic broiler chickens from 7 different flocks were used in this study. An experimental investigation was also conducted to induce ascites in broiler chickens by creating a hypoxic condition. In the first trial 32 birds were exposed to periodic hypoxia (6 and 12 hrs/day) and in the second trial 24 birds were exposed to periodic hypoxia (6 hrs/day) and fed on pelleted feed. The experimental period was 4 weeks. All

976 Monitoring energy expenditure in sheep from daily heart rate measurement. A Arieli^{*1}, A Kalouti², Y Aharoni³, and A Brosh³, ¹Hebrew University of Jerusalem, Israel, ²Wageningen Agricultural University, Netherlands, ³Agricultural Research Organization, Ramat Yishay, Israel.

A trial was conducted in sheep to validate the usage of continuous heart rate (HR) monitoring for the prediction of energy expenditure (EE) in free-living animals. Sixteen Assaff lambs (BW 50 kg) were used. Four lambs were slaughtered at the beginning of the experiment, and the others at the end of the experiment. Carcass body composition was analysed and energy retention was calculated. The 12 lambs were kept on metabolic crates for 84 d. Lambs were blocked into 3 dietary treatments: Group HH was fed a 75:25 concentrates: alfalfa hay (C:A) diet during the entire experiment. Group LH were fed 25C:75A diet during the first 42 d, and then switched into a 75C:25A diet. Group LL received 25C:75A diet during the entire experimental period. Feed was given ad libitum. The experimental period was divided into 4 sub-periods of 21 d. During each sub-period, body weight change, daily intake and feces output was measured. Intake of ME was calculated from NRC (1989). HR was recorded by data loggers during 15 to 17 d. On 18 d oxygen consumption (VO₂), using an open circuit mask system, and HR were measured for a period of 15 min, from which oxygen pulse (OP = VO₂:HR ratio) was determined. For each sub-period EE was estimated from daily HR measurements and oxygen consumption, calibrated against OP. Direct measurement of EE could thus be compared with the prediction obtained from the difference between ME intake (MEI) and measured energy retention. Average (and SE) intakes of ME were 857 (33), 854 (39), and 805 (42) kJ/metabolic body weight (MBW)-d in HH, LH, and LL, respectively. The respective energy retentions were 194 (23), 233 (27) and 141 (22) kJ/MBW-d ($P = 0.06$). Overall energy predictability (MEI/(energy retention + EE estimated by the HR method) was 0.957 ($n = 12$; SE 0.024), and was not affected by dietary energy concentration. It is concluded that the HR technique can be used for the estimation of long-term energy expenditure in growing animals.

Key Words: Energy expenditure, Heart rate, Oxygen pulse

exposed birds were investigated for haematological, histopathological, immunohistochemical, and ultrastructural studies. Pathomorphological examination revealed degenerative myocarditis, granulomatous and fibrinopurulent pneumonia, 25% of experimental birds developed ascites, and haematological and pulmonary changes were prominent in them. It was concluded that ascites syndrome in broiler chickens is multifactorial in origin, and heart and lungs are central organs in the pathogenesis of ascites. The development of ascites in hypoxic birds is mediated through haematological and pulmonary changes.

Key Words: Ascites, broiler chicken, Hypoxia

979 Experimental study on sodium intoxication in relation to ascites syndrome in broiler chickens. M. Mubarak^{*}, A.H. Bayoumi, A.Z. Mahmoud, M.S. Youssef, and S. Mousa, *Vet. Med., Assiut Univ., Assiut, Egypt.*

This work was designed to induce ascites in broiler chickens by sodium chloride intoxication. Three experiments were conducted using 40, 40, and 50 chickens, respectively, which received high doses (1.5%) and low doses (0.75%) of sodium chloride (SC), sodium bicarbonate (SB), and sodium phosphate (SP) in their drinking water for 4 weeks. Haematologic parameters, serum level of sodium, creatine kinase and lactate dehydrogenase were estimated. Histopathological and ultrastructural studies were also performed. Ascites was not recorded in high dosed birds. Low dosed birds manifested ascites at the incidence of 40% (SB), 35% (SC), and 10% (SP). Cardiac and pulmonary lesions were observed in ascitic birds. It was concluded that pathogenesis of ascites in sodium intoxicated birds is mediated through pulmonary hypertension induced right sided heart failure.

Key Words: Ascites, broiler chicken, sodium chloride toxicity

980 Detection of experimental *Salmonella enteritidis* and *S. typhimurium* infections in laying hens by fluorescence polarization assay for egg yolk antibodies. R. K. Gast^{*1}, M. S. Nasir², M. E. Jolley², P. S. Holt¹, and H. D. Stone¹, ¹USDA-ARS Southeast Poultry Research Laboratory, Athens, GA, ²Diachemix Corporation, Grayslake, IL.

The effectiveness of risk reduction programs for controlling egg-borne transmission of *Salmonella* infections to humans depends on accurate detection of infected commercial laying flocks. Although most *S. enteritidis* (SE) control programs in the U.S. have emphasized bacteriological detection of the pathogen in laying house environments and eggs, antibody detection methods have been used successfully elsewhere and are of particular interest in application to egg yolks (which can be collected more conveniently than serum samples). Fluorescence polarization (FP) technology offers advantages over traditional enzyme immunoassays in terms of both speed and methodological simplicity. This study evaluated the sensitivity and specificity of detection of antibodies in the yolks of eggs laid by experimentally infected chickens by FP assays using tracers prepared from the O-polysaccharides of SE and *S. typhimurium* (ST) and an ELISA using an SE flagellin antigen. In 2 trials, groups of specific-pathogen-free laying hens were infected orally with either 10^6 or 10^8 cfu of SE (phage type 13a) or with 10^8 cfu of ST. Egg yolks were obtained at 5 weekly intervals from infected and uninfected negative control hens. Both ELISA and FP (using SE tracers) detected a high percentage of hens infected with SE, although both assays also detected antibodies in eggs from some hens infected with ST. The FP assay for SE was both more sensitive and more specific than the ELISA. Two different SE tracers for FP displayed different sensitivities and specificities of detection. FP using an ST tracer likewise detected ST infection but cross-reacted with antibodies to SE.

Key Words: *Salmonella enteritidis*, Fluorescence polarization, Egg yolk antibodies

981 The role of intracellular sodium in skeletal muscle damage: effects on muscles from two broiler genotypes. D. A. Sandercock^{*} and M. A. Mitchell, *Roslin Institute, Roslin, Midlothian, UK.*

The incidence of idiopathic myopathy is increasing in poultry lines selected for high growth rates and muscle yields. The condition has been linked with impaired muscle intracellular calcium (Ca^{2+}_i) homeostasis. Elevations in Ca^{2+}_i are known to be associated with the development of myopathy. These increases may be mediated by initial changes in other ions, such as sodium (Na^+). This study examines the role of Na^+ on Ca^{2+}_i and muscle damage and compares its effects on these parameters in muscles from two broiler genotypes. The study employed an isolated in vitro chicken skeletal muscle preparation. Alterations in Na^+ were induced using the Na^+ ionophore monensin and Na^+/K^+ exchange inhibitor ouabain. In a parallel experiment, muscles from fast (FG) and slow (SG) growing broiler lines were similarly treated. Muscle damage was determined from creatine kinase (CK) loss into the incubation medium. Muscle calcium accumulation was estimated by $^{45}\text{Ca}^{2+}$ uptake. Monensin and ouabain treatments both caused similar elevations in $^{45}\text{Ca}^{2+}$ uptake ($p < 0.05$) and were associated with increases in CK loss ($p < 0.001$). Effects of simultaneous incubation with both agents were additive. In studies on muscles from FG and SG lines, $^{45}\text{Ca}^{2+}$ uptakes and CK losses were not different under control conditions. Treatment with monensin produced differential increases in $^{45}\text{Ca}^{2+}$ uptake ($p < 0.01$) and CK loss ($p < 0.001$) in muscles from the two lines. Absolute uptakes of $^{45}\text{Ca}^{2+}$ ($p < 0.05$) and CK losses ($p < 0.001$) were greater in muscles from the FG line as were their relative increases ($p < 0.05$). The results suggest initial increases in Na^+ can produce elevations in Ca^{2+}_i and muscle injury. FG and SG lines exhibit differences in the extent of Na^+ -mediated alterations in muscle Ca^{2+}_i and CK loss. It is proposed that subjecting birds to situations which may cause changes in muscle Na^+ (e.g. raised muscle activity and stress) should be avoided, especially in current broiler lines, in which sensitivity to Na^+ -induced changes in myopathology appears to be increased.

Key Words: Sodium, Muscle damage, Broiler

982 Idiopathic myopathy in commercial turkeys: a relationship with muscle fiber diameter? M.A. Mitchell^{*1}, L.J. Mills¹, M. Mahon², and S. Gilpin², ¹Roslin Institute, Roslin, Midlothian, UK, ²Manchester University, Manchester, UK.

Previous studies in this laboratory have described an age dependent, idiopathic or spontaneous myopathy in rapidly growing commercial turkeys associated with an exponential rise in plasma creatine kinase (CK) activity. These effects were not found in an unimproved strain. Growth restriction in commercial turkeys reduced plasma CK, suggesting a link between growth rate, bodyweight and myopathy. The aim of this experiment was to correlate the incidence and extent of this pathology with morphometric characteristics of the muscle fibers. Large, white commercial male-line stags were reared to two weeks of age and split into 2 treatment groups. One group was fed ad libitum (AL) throughout the experiment and the other treatment group was restricted from 5 weeks of age (R), receiving 70% of the reported ad lib food intakes. Every four weeks up to 20 weeks of age 8 birds per treatment were weighed and blood sampled. Plasmas were analyzed for CK activities. Histological analyses were performed upon muscle samples from leg and breast. Bodyweights, fiber diameters and plasma CK activities increased significantly with age in both treatments and were significantly greater in the AL treatment ($p < 0.001$). At 8 weeks body weight and CK activities were significantly higher ($p < 0.001$) in the AL treatment and by 12 weeks fiber diameter was also significantly increased ($p < 0.001$). Regression analysis highlighted almost identical exponential relationships between CK and bodyweight and between CK and fiber diameter for both treatment groups ($p < 0.001$). The take-off point for CK corresponded to approximately 10kg bodyweight and 65mm fiber diameter in both treatments. It is suggested that myopathy is linked to muscles fiber size rather than the rate of growth. Selection in commercial turkeys has achieved greater muscle weights mainly through fiber hypertrophy. The resulting large diameter fibers may exceed a size threshold at which normal function is compromised and pathology occurs. Future selection programs may benefit by concentrating on selection for smaller fiber sizes and greater fiber numbers (hyperplasia) to achieve high muscle yield, good meat quality and muscle health.

Key Words: Turkey, Muscle, Myopathy

983 Bacteriophage prevents *Escherichia coli* respiratory infection in broiler chickens. W. E. Huff^{*}, G. R. Huff, N. C. Rath, J. M. Balog, H. Xie, P. A. Moore, Jr., and A. M. Donoghue, *PPPSRU/ARS/USDA Fayetteville, AR.*

Bacteriophage are viruses that infect and can kill bacteria. A study was conducted to determine if bacteriophage could protect broiler chickens challenged with *E. coli*. There were 13 treatments with 2 replicate pens of 10 chicks. Two treatments consisted of birds challenged at 3 days of age with either 10^3 or 10^4 cfu *E. coli* injected into the thoracic airsac. There were 4 phage treatments that consisted of mixing a bacteriophage isolated from a municipal sewer treatment plant with *E. coli* 24 hours prior to challenging the birds. The 10^3 *E. coli* culture was mixed with either 10^3 or 10^6 phage, and the 10^4 *E. coli* culture was mixed with either 10^4 or 10^8 phage. Four treatments consisted of challenging the birds with only 10^3 , 10^4 , 10^6 , or 10^8 phage. Three control treatments consisted of unchallenged birds, birds challenged with the culture broth, or birds challenged with phosphate buffered saline. The birds were necropsied at 3 weeks of age. At 1 and 2 weeks of age birds challenged with either 10^3 or 10^4 cfu of *E. coli* had significantly decreased body weights from controls. At 2 weeks of age the birds that received 10^4 cfu of *E. coli* mixed with 10^4 bacteriophage had significantly decreased body weights from the controls. Mortality in the birds that received 10^3 or 10^4 cfu of *E. coli* was 80 and 85%, respectively. Mortality of birds that were challenged with either 10^3 or 10^4 cfu of *E. coli* mixed with equal amounts of bacteriophage was 25 and 45%, respectively. Mortality of birds challenged with 10^3 or 10^4 cfu of *E. coli* mixed with 10^6 or 10^8 bacteriophage was 5 and 0%, respectively. Based on mortality there was essentially complete protection of the birds given either 10^3 or 10^4 cfu *E. coli* mixed with either 10^6 or 10^8 bacteriophage, and partial protection when equal amounts of *E. coli* and bacteriophage were mixed prior to challenge. These data suggest that bacteriophage may have efficacy to prevent *E. coli* respiratory infections in broiler chickens.

Key Words: Bacteriophage, Broiler chickens, *Escherichia coli*

984 Efficacy of bacteriophage to prevent *Escherichia coli* respiratory infection in broiler chickens when administered in the drinking water prior to challenge. W. E. Huff*, G. R. Huff, N. C. Rath, J. M. Balog, H. Xie, P. A. Moore, Jr., and A. M. Donoghue, *PPPSRU/ARS/USDA Fayetteville, AR*.

Bacteriophage are viruses that can infect and kill bacteria. A study was conducted to determine if bacteriophage added to drinking water for 1 wk prior to respiratory challenge of broiler chickens with *E. coli* would provide protection. There were 12 treatments with 2 replicate pens of 10 chicks. The treatments consisted of birds on normal water challenged at 1 wk with either 10^3 or 10^4 cfu *E. coli* injected into the thoracic airsac, or with either 10^3 , 10^6 , or 10^4 , 10^6 phage/ml in their water, respectively. Unchallenged birds were given either 10^3 , 10^4 , or 10^6 phage/ml in their water, and birds on normal water were unchallenged, challenged with the culture broth, or with phosphate buffered saline. The birds were necropsied at 3 wks of age. At 2 wks, birds challenged with 10^4 *E. coli* regardless of water treatment, and birds challenged with 10^3 *E. coli* on normal water had decreased BW, however, birds challenged with 10^3 *E. coli* and given water treated with either 10^3 or 10^6 phage/ml had higher BW than birds challenged with 10^3 *E. coli* on normal water. At 3 wks, unchallenged birds that received 10^3 phage, and birds that received 10^4 phage and challenged with 10^4 *E. coli* had decreased BW. At 1 wk, treatment of water with 10^6 phage/ml decreased mortality by 50% in birds challenged with 10^3 *E. coli*. Total mortality was 55% in the birds that received 10^4 *E. coli* alone, 35% when treated with 10^4 phage, and 40% when treated with 10^6 phage. These data indicate that treating the water of broiler chickens prior to a respiratory challenge with *E. coli* may have provided some protection immediately after challenge.

Key Words: Bacteriophage, Broiler chickens, *Escherichia coli*

Ractopamine at One Year of Commercial Application

986 Biological basis of the ractopamine response. S.E. Mills*, *Purdue University*.

Ractopamine belongs to a class of compounds that binds beta-adrenergic receptors (β AR) and promotes the accretion of muscle protein while reducing body fat. The growth response is observed across many species and with a variety of structurally related compounds, suggesting that a common regulatory pathway is involved. The β AR-selective agonist isoproterenol also stimulates muscle growth in rodents suggesting that β AR, and not other receptors, mediate the hypertrophic response. Three β AR subtypes have been cloned from several mammalian species and specie differences in the relative distribution and pharmacology of subtypes have been demonstrated. These specie differences likely account for the lesser or greater efficacy of specific compounds in specific species. In the pig, the β 1AR is the predominant subtype expressed in the adipocyte (75%) and skeletal muscle (60%), followed by the β 2AR (18 and 39%) and β 3AR (7 and 1%). Ractopamine binds the porcine β 1AR and β 2AR with similar high affinity ($K_d = 25$ to 100 nM). Intracellular signaling through the β AR is achieved via activation of adenylyl cyclase and generation of cAMP. Ractopamine activates adenylyl cyclase but is only 20 to 40% as effective as isoproterenol and may more effectively signal through the β 2AR than the β 1AR. Ractopamine would be considered a partial agonist at both β AR subtypes. In adipose tissue, ractopamine stimulates triglyceride hydrolysis in vivo and in vitro through activation of adenylyl cyclase. Absolute rates of fat accretion are not consistently observed in feeding studies however, likely due to the combination of β AR down regulation with chronic feeding and the partial agonist activity. Ractopamine consistently increases the rate of skeletal muscle protein accretion in pigs, although the response is diminished with time. Down regulation of β AR is less evident in skeletal muscle, which may prolong the positive effect. It is not clear which β AR subtype(s) are linked to protein accretion and what intracellular path-

985 Effect of feed supplementation with vitamin D metabolites in a dexamethasone-*Escherichia coli* challenge model of turkey osteomyelitis complex. G. R. Huff*, W. E. Huff, N. C. Rath, and J. M. Balog, *PPPSRU/ARS/USDA, Fayetteville AR*.

Supplementation with vitamin D₃ was previously shown to protect *E. coli* challenged birds which were immunosuppressed with dexamethasone (DEX) at 5 wk and at 12 wk of age. The purpose of this study was to determine the effects of continual dietary supplementation with either 10 g/kg 1,25 dihydroxyvitamin D₃ (1,25) or 99 g/kg 25-hydroxyvitamin D₃ (Hy-D) on disease resistance. Seven hundred twenty turkey poults were placed into 24 duplicated floor pens in a 3 X 2 X 2 design comparing each metabolite treatment to controls. At 5 wk of age half of the birds were treated with DEX and half of the DEX-treated birds were challenged with *E. coli*. All mortalities and lame birds were necropsied. At 9 wk all DEX-treated birds were treated with another series of DEX injections. At this time, the birds which had only been challenged with *E. coli* were also treated with DEX. Two weeks later 10 birds/pen were necropsied. After the first series of DEX injections, there was an increase in mortality in the Hy-D supplemented birds which were given both the DEX treatment and the *E. coli* challenge. After the second series of DEX injections the main effect mean body weights were lower in birds given 1,25 as compared to both controls and Hy-D supplemented birds. Mortality was higher in 1,25 supplemented birds which were challenged with *E. coli* at 5 wk and treated with DEX at 9 wk as compared to Hy-D supplemented birds. The 1,25-treated birds which were treated with DEX at both 5 wk and 9 wk and challenged with *E. coli* at 5 wk had higher mortality as compared to both controls and Hy-D birds. The main effect mean mortality was higher in birds given 1,25 as compared to controls and Hy-D birds. The percentage of birds with lesions of turkey osteomyelitis complex (TOC) was decreased from 27% to 0 by both Hy-D and 1,25 in the groups given 2 DEX treatments and *E. coli* challenge. This study suggests that continual supplementation with vitamin D metabolites at these levels can decrease TOC incidence, however this result may be related to a concomitant increase in mortality.

Key Words: vitamin D, turkeys, *Escherichia coli*

ways are involved. Answers to these questions may provide insights for the next generation of β AR agonist.

Key Words: pig, adrenergic, receptor

987 Impact of nutrition on the ractopamine response. W. C. Weldon* and T. A. Armstrong, *Elanco Animal Health, Greenfield Indiana*.

Proper nutrition is critical to effective implementation of ractopamine (Paylean®) in commercial swine production facilities. There is only a limited response to ractopamine if it is included in diets with limited amino acid fortification. Very simply, the ability of ractopamine to increase lean growth is limited by the availability of nutrients. To make an accurate estimate of the optimal nutrient concentration, it is critical to understand the potential lean growth response to ractopamine. The growth response to ractopamine is dramatic. Several studies have shown that the inclusion of ractopamine in the diet will increase ADG by as much as 275 g/d during the early weeks of ractopamine feeding. The improvements in growth performance decrease over time. Current recommendations are to feed ractopamine so that the majority of the pigs are marketed within four weeks of the initiation of ractopamine feeding. Practically, the primary adjustment necessary in diets containing ractopamine is to increase the amino acid concentration. A summary of four historical data sets indicates that the increased lean growth requires 3.6 to 7.5 g/d more true ileal digestible lysine during 28 d of ractopamine feeding (based on NRC 1998). If the increased lysine needs are distributed based on the relative response in ADG, the lysine requirement is greatest during the first few weeks of ractopamine feeding. The average increase in lysine requirements for the first 21 d of ractopamine feeding (based on historical lean growth data using NRC (1998) calculations) is 6.5 g/d of true ileal digestible lysine. Therefore, if pigs consume 2.5 kg of feed/d, the concentration of true ileal digestible lysine in the diet would need to be increased 0.26%. The results from ongoing studies will further define the interactions between dose and feeding duration