
The negative effects of high environmental temperatures (T) on growth and muscle accretion in chickens are often confounded by a reduction in feed consumption. The growth performance of broiler chickens of slow (Red Ranger) and fast (Ross 708) growth strains were assessed when reared under neutral (NT), warm (WT), and pair-fed N (PNT; birds in NT fed the amount of feed consumed by those in WT) conditions to separate the direct (T) and indirect (reduced appetite) effects of WT. A total of 1,008 male chicks were reared in 12 environmentally controlled rooms (4 rooms/T; 2 pens/room) to 55 d. Tissue and blood samples were collected from 2 birds/pen for muscle histology and plasma creatine kinase (CK) levels at 55 d. Six per pen (144 total) were processed to determine carcass yields, breast meat quality (color, pH, drip loss), and the incidence and severity of white striping (WS), woody breasts (WB), and necrotic fillets (NF). Slaughter BW differed significantly (P < 0.001) between the slow and fast growth strains and among NT (2,392 vs. 4,642 g), WT (2,148 vs. 3,354 g) and PNT (2,065 vs. 3,669 g), respectively. Carcass yields differed by strain (P < 0.001), with fast growth strain showing significantly higher average myofiber diameter. The proportion of breast fillet and tenders were reduced (P < 0.001) with WT, as compared with NT and PNT. Breast fillet were lighter in color in fast (L* = 56) compared with slow growth (L* = 51.8) strain. The proportion of breast fillets with severe WS, WB and NF was affected (P < 0.001) by strain (fast > slow), as well as rearing T (NT > WT > NPT). Incidence of severe WB (37.5 vs. 12.5%) and NF (33.3 vs. 7.3%) were significantly reduced in PNT compared with WT trt. Plasma CK levels were highest for fast growth strain and increased from 49 to 55 d of age in NT due to high rate of muscle growth and protein turnover. Negative effects of T on meat yields, quality and breast myopathies were more acute with the fast growth strain in this study.

Key Words: breast, broiler, temperature, yield, myopathy

259 Postmortem changes in the water-holding capacity of broiler breast meat. B. Bowker* and H. Zhuang, USDA-ARS, Athens, GA.

The objective of this study was to evaluate the effect of vacuum-tumbling marination on CIELAB L* values of early-deboned broiler breast fillets (p. major) with different color lightness. Early deboned (2 h postmortem) broiler fillets were visually selected based on their color lightness from a commercial plant and sorted into 3 color lightness groups: light, medium, and dark. Samples were marinated in a vacuum tumbler (−0.6 atm, 16 rpm, 20 min) with 20% wt/wt marinade at either 6 or 24 h postmortem yielding 0.75% NaCl and 0.45% phosphate in the final product. Non-marinated fillets served as controls. Fillet surface CIELAB L* was measured using a Minolta CM-700d spectrophotometer at 2 h (pre-marination) and 48 h postmortem (post-marination). For the non-marinated light fillets, there was no difference in L* values at 2 h (mean L* value of 60.6) and 48 h postmortem (61.4); however, L* values of marinated fillets (56.3) were less (P < 0.05) than those of control fillets regardless of the postmortem time of marination (6 or 24 h). For the non-marinated medium fillets, L* values measured 48 h postmortem (58.3) were greater (P < 0.05) than at 2 h postmortem (<53.5), but there were no differences between marinated and control samples. The postmortem time of marination (6 vs. 24 h) did not have a significant effect (P > 0.05) on the L* value of any of the fillets regardless of initial color lightness. Overall, marination reduced L* values in light and medium color fillets; however, for dark fillets, L* values were not affected by marination. These results demonstrate that tumbling marination can significantly affect CIELAB L* values (color lightness) of chicken fillets and that the effects depend on initial raw meat lightness.

Key Words: chicken, breast meat, marination, color, CIELAB L*
The objective of this project was to assess the effect of dietary conjugated linoleic acid (CLA) on the fatty acid composition and lipid oxidation stability of chicken meat. Six hundred broiler chicks were raised up to 6 weeks of age. Broilers were fed a basal corn-soybean meal diet including soybean oil (SB), CLA (Lutalin, BASF), or a 1:1 SB-CLA mixture, at 2% and 4% diet inclusion levels. Broilers were randomly assigned into 6 treatments with 4 replications, each with 25 broilers. At the end of the feeding period, broilers were slaughtered following commercial-like procedures. Breast and thigh meat samples were collected, skinned, deboned, and trimmed of fat and connective tissue. Separately, the meat was ground and formed into patties of 150 g, followed by cooking in a convection oven up to 74°C internal temperature. Cooked meat patties were cooled at room temperature for 1 h, placed in plastic bags, and stored in refrigerated conditions during 0, 3, 6, and 9 d. TBARS analysis was conducted at each storage day, malonaldehyde (MDA) values were quantified in the meat. The results showed an important effect of the dietary oils on the fatty acid composition of the meat. Muscle from the CLA treatment showed a higher significant (P < 0.05) content of saturated fatty acids and deposition of cis-9,trans-11 and trans-10,cis-12 CLA isomers, compared with the SB treatment. Dietary oils also affected the lipid oxidation stability of breast and thigh meat. For instance, in breast meat the lowest MDA values were detected in the CLA treatment (0.9, 2.0, 3.4, and 4.2 mg/kg in d 0, 3, 6, and 9, respectively), intermediate values in the SB-CLA (0.9, 2.8, 4.6, and 6.0 mg/kg in d 0, 3, 6, and 9, respectively), and the highest values in the SB treatment (1.2, 4.6, 6.5, and 10.1 mg/kg in d 0, 3, 6, and 9, respectively), with significant differences starting at d 3 of storage (P < 0.05). Similar differences were observed in thigh meat. In conclusion, feeding dietary CLA oil to broilers induces the deposition of CLA isomers and higher proportion of saturated fatty acids in the muscle, and lowers the susceptibility of cooked meat to lipid oxidation development when compared with SB oil or SB-CLA mixture.

Key Words: CLA, meat, lipid oxidation stability

262 Assessment of density in enriched colony cages: Egg quality, D. R. Jones1, and D. M. Karcher2, 1Egg Safety and Quality Research Unit, USDA-ARS, Athens, GA, 2Department of Animal Science, Michigan State University, East Lansing, MI.

Enriched colony cage production systems are becoming more prevalent in the United States. A study was undertaken to determine the effect of housing density on hen health, well-being, egg production and quality. Six densities were examined with 8 housing replicates per density. Egg quality was assessed at hen ages 22, 35, 49, and 64 wks. Cracked eggs were removed and eggs were stored overnight at 5C before analysis. All egg quality measurements were completed the following day and monitored on a per egg basis, except for yolk color which was conducted on pools. A density × hen age (P < 0.05) interaction existed for shell compression vitelline membrane strength and elasticity were greatest at 22 wk (272.56 g and 8.53 mm, respectively) and lowest at 64 wk (125.58 g and 6.68 mm, respectively; P < 0.05). Shell thickness decreased as hens aged but at different rates for the 6 densities (P < 0.05). Hen age affected all egg quality measurements monitored. Density and hen age affected the rate of change in shell thickness, shell dynamic stiffness, and Haugh units. Currently, no clear recommendations can be made for enriched colony cage density and resulting egg quality.

Key Words: enriched colony cage, egg quality, egg weight, Haugh unit, density

263 Horizontal transmission of Salmonella Enteritidis in experimentally infected laying hens housed in conventional or enriched cages. R. Gast1, R. Guraya2, D. Jones3, and K. Anderson4, 1USDA-ARS, Egg Safety and Quality Research Unit, Athens, GA, 2North Carolina State University, Raleigh, NC.

The majority of human illnesses caused by Salmonella Enteritidis are attributed to contaminated eggs, and the prevalence of this pathogen in commercial laying flocks has been identified as a leading epidemiologic risk factor. Flock housing and management systems can affect opportunities for the introduction, transmission, and persistence of food-borne pathogens in poultry. The animal welfare implications of different types of housing for laying hens have been widely discussed in recent years, but the food safety consequences of these production systems remain incompletely understood. The present study assessed the effects of 2 different housing systems (conventional cages and colony cages enriched with perching and nesting areas) on the horizontal transmission of experimentally introduced S. Enteritidis infection within groups of laying hens. In each of 2 trials, 136 hens were distributed among cages of both housing systems and approximately one-third of the hens in each cage were orally inoculated with doses of 1010 cfu of S. Enteritidis (phage type 13a in one trial and phage type 4 in the other). At regular intervals through 23 d post-inoculation, cloacal swabs were collected from all hens (inoculated and uninoculated) and cultured for S. Enteritidis. Horizontal contact transmission of infection was observed for both S. Enteritidis strains, reaching peak prevalence values of 27.1% of uninoculated hens in conventional cages and 22.7% in enriched cages. However, no significant differences (P > 0.05) in the overall frequencies of horizontal S. Enteritidis transmission were evident between the 2 types of housing. These results suggest that opportunities for S. Enteritidis infection to spread horizontally throughout laying flocks may be similar in conventional and enriched cage-based production systems.

Key Words: Salmonella Enteritidis, chicken, horizontal transmission, conventional cage, enriched cage

264 Prevalence, serotypes, and antibiotic-resistant phenotypes of Salmonella enterica isolates in retail poultry products. C. S. Sharma1, Ates, Mississippi State University, Mississippi State, MS.

The objective of this study was to determine the prevalence of Salmonella and antibiotic resistant Salmonella phenotypes in retail poultry products. Ground turkey (n = 120) and skinless, boneless chicken breast fillet (n = 117) samples were randomly collected from 3 different local grocery stores. All samples were analyzed for the presence of Salmonella using selective enrichment procedure of the USDA FSIS. Salmonella isolates were confirmed by serology and biochemical characterization.
All the isolates were serotyped. Antibiotic resistant phenotypes of *Salmonella* isolates were determined as per the Clinical and Laboratory Standards Institute method. *Salmonella* was detected in 16.7% (20/120) and 11.1% (13/117) of ground turkey and chicken breast fillet samples, respectively. The predominant serotypes isolated from ground turkey were *S. Heidelberg* and *S. Saintpaul* (7 isolates each), whereas *S. Typhimurium* var 5–10 isolates was the primary serotype isolated from chicken breast samples. All except one isolates of *S. Typhimurium* var 5– were resistance to sulfisoxazole and tetracycline. Among turkey isolates, 4 isolates were pan-susceptible, 5 isolates displayed resistance to 1 single antibiotic, 1 isolate to 2 drugs, 3 isolates to 3, 4 isolates to 4, 2 isolates to 7 drugs, and 1 isolate to 10 antimicrobials. Multidrug resistance (MDR) was primarily observed in *S. Heidelberg* isolates. All the 7 *S. Heidelberg* isolates were resistant to at least 3 antibiotics. The prevalence of MDR *Salmonella* in retail poultry products can be a food safety concern and more effective measures are needed to eliminate the prevalence of MDR *Salmonella* strains in retail poultry products.

**Key Words:** *Salmonella*, ground turkey, chicken breast, antibiotic resistance, serotype

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**Bacterial poultry pathogens and control with natural and organic antimicrobial.** N. Chowdhury, S. Salalheen, J. A. Almario, M. Peng, and D. Biswas*, University of Maryland, College Park, MD.

*Staphylococcus aureus*, *Pasteurella multocida*, *Salmonella* Pullorum, and *Salmonella* Gallinarum are recognized as the common poultry bacterial pathogens in both pasture and conventional production systems and are associated with reduced animal health and economic losses to farmers. Management strategies to prevent and control of these pathogens are lacking whereas cure rates using antibiotics or vaccination vary considerably due to several limitations. In addition, antibiotic use is coming under increasing public scrutiny due to the possible development of resistant pathogens. Therefore, new strategies to control or treat of the diseases caused by these pathogens are warranted. The objective of this study was to investigate the role of alternative therapeutic intervention to reduce diseases with these bacterial pathogens in poultry using bioactive components from citrus oil and berry pomace extracts. Growth inhibition experiments with berry pomace extracts, and citrus oil and its fractions were carried out using broth dilution method. Cytotoxic effects of the functional components against relevant cell culture models were also performed. We found that growth of *S. aureus*, *P. multocida*, *S. Pullorum*, and *S. Gallinarum* were inhibited by >5 logs by blackberry pomace extracts and growth of *S. aureus* and *P. multocida* were reduced by >4 logs in the presence of blueberry pomace extracts, respectively. Citrus oil and its 2 fractions (linalool and citral) reduced the growth of these bacterial pathogens by >5 logs, except effect of citral against *S. Gallinarum*. But the minimum bactericidal concentrations showed mixed cytotoxic effect against cultured mammalian cells used in this study. The use of citrus oil and its fraction and bioactive fractions of pomace extracts could be a promising new therapeutic option for improving control and treatment of *S. aureus*, *P. multocida*, *S. Pullorum* and *S. Gallinarum* diseases in poultry. This study also indicates that these natural anti-microbials can be used economically as alternative therapeutic agents deliver through as feed and/or water supplements and control production losses.

**Key Words:** *Staphylococcus aureus*, *Pasteurella multocida*, *Salmonella* Pullorum, *Salmonella* Gallinarum

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**Effect of vaccine and Echinacea purpurea extract on colonization of broilers with Campylobacter jejuni.** H. Ebrahimi¹, S. Rahimi*¹, P. Khaki², G. Sajadi³, A. Rahimi², and M. Naghizadeh³, ¹Tarbiat Modares University, Tehran, Iran, ²Razi Vaccine and Serum Production Research Institute, Karaj, Iran, ³Islamic Azad University, Tehran, Iran.

Campylobacter jejuni is a zoonotic bacterial pathogen with worldwide distribution. It is estimated that 400 million human infections occur in the world per annum. Chickens which are often heavily colonized with *Campylobacter* show no pathologic signs and are considered as the most important source for human infection. Therefore, there is a critical need to reduce *Campylobacter jejuni* populations in the gastrointestinal tract of broilers. In this study, we investigated the effect of a formalin-inactivated *C. jejuni* whole-cell vaccine and *Echinacea purpurea* alcoholic extract (EPAE) as stimulator of the immune system on levels of *C. jejuni* in the cecum of broilers. EPAE was provided in drinking water (1:1000, vol/vol) until d 14 and then 8 h per day. Day-old male broiler chicks (Ross 308) were randomly assigned to 7 treatment groups, each with 30 birds (10 in each of 3 separate pens). Treatments differed in regard to whether the vaccine was administered, the timing of vaccination (d 1 vs. vaccination on both d 1 and d 14, by inoculation in crop (gavage)), and whether EPAE was administered. Birds were challenged on d 21 by gavage of 1 mL (6 × 10⁷ cfu/mL) of the same *C. jejuni* strain employed for the preparation of the vaccine. On d 28 and 42, 2 birds/pen were euthanized, and cecal contents were used for *C. jejuni* enumeration. The inactivated *Campylobacter* vaccine resulted in a 65% decrease in CFUs of *C. jejuni* in the cecum (9.67 vs. 10.12 log₁₀ cfu/mL; P < 0.001). The decrease was most pronounced in the presence of EPAE (P < 0.001), suggesting a synergistic interaction between the vaccine and EPAE in the observed reduction of *C. jejuni* colonization. Result of immune system tests also showed strong and positive effect of EPAE on immune system of broilers (P < 0.001).

**Key Words:** broiler, *Campylobacter jejuni*, colonization, *Echinacea purpurea*, vaccination

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**Feeding XPC can reduce Campylobacter in broilers.** D. R. McIntyre*¹, C. L. Hofacre², and G. F. Mathis³, ¹Diamond V; Cedar Rapids, IA, ²University of Georgia, Athens, GA, ³Southern Poultry Research Group, Athens, GA.

Broiler chickens were challenged with *Campylobacter coli* to evaluate the effects of XPC on *C. coli* colonization and transmission. Day-old Cobb chicks (n = 1200) were housed in 24 floor pens with 1 of 3 feed treatments (T). T1 birds received Starter (S), Grower (G) and Finisher (F) feed. T2 and T3 received the S plus XPC at 2.5 lb/t from 0 to 21 d: then 1.25 lb/t for T2 and 2.5 lb/t for T3. No feed antibiotic or coccidiatostat was used. The birds were vaccinated with Coccivac-B at 0 d. At 14 d, 25 tagged birds/pen were orally gavaged with a gentamicin resistant strain of *C. coli* (10⁶ cfu/mL). The remaining 25 birds/pen were not tagged or challenged. At 35 and 42 d, birds and feed were weighed. Then at 42 d, 15 birds/pen (5 tagged and 10 nontagged) were sampled and the ceca removed for *C. coli* colonization. No differences were observed for weight gain or livability. FCR was improved (P < 0.05) by the addition of XPC at both levels (1.90, 1.90 vs. 1.93, for T2, T3, and T1, respectively). *C. coli* prevalence (% positive) in 42 d contact-challenged birds was reduced in T3 (P = 0.02) compared with T1, with T2 being intermediate (17.5, 10.0, and 1.3% for T1, T2, and T3, respectively). T3 had the lowest MPN (P = 0.09) for contact-challenged birds (37, 14, and 0.94 MPN/g, for T1, T2, and T3, respectively). Based on these
results, XPC-fed broilers had improved FCR and a lower prevalence and load of Campylobacter at market age.

Key Words: Campylobacter, food safety, broiler

268 Feeding XPC reduces Campylobacter in turkey hens. D. Smith*, J. Grimes1, M. Crespo Rodriguez1, C. Shenton1, I. Barasch1, C. Evans1, and S. Essick1, 1Prestige Department of Poultry Science, North Carolina State University, Raleigh, NC, 2Diamond V, Cedar Rapids, IA.

Commercial turkey hens were challenged with Campylobacter (C.) coli to evaluate the effects of XPC, a product containing fermentation metabolites, on C. coli colonization and transmission. Day-old Hybrid hen poult (n = 288) were assigned to either Treatment (T) or Control (C) with 12 floor pens each and 12 birds/pen. Four diets were fed from 0 to 12wk: Starter 1 (S1), Starter 2 (S2), Grower 1 (G1), and Grower 2 (G2). T birds had XPC at 2.5lb/t in S1 and S2 and 1.25lb/t in G1 and G2; C birds received no XPC. No antibiotic or coccidiostat was used in any feed. All birds and feed were weighed at 10 and 12 wk. At 10 wk, 5 birds/pen were caged orally gavaged (direct inoculation, DI) with a gentamicin-resistant marker strain of C. coli (10^6 cells/mL). The other 7 birds/pen were not challenged and were used to assess horizontal transmission (HT) of C. coli. At 12 wk, 10 birds/pen (5 DI and 5 HT) were euthanized and ceca were removed for cecal contents was direct plated onto CCDA+gentamicin (200 ppm) to determine numbers of C. coli were reduced from 4.5 to 3.5 log_10 cfu/g in C vs. T birds, respectively. Results indicate XPC-fed turkey hens had improved FCR, lower prevalence of C. coli among birds exposed to horizontal transmission, and overall lower numbers of C. coli at market age.

Key Words: Campylobacter coli, turkey hen, food safety

269 The effectiveness of direct-fed microbial and prebiotic on histomorphology of intestine, ultrastructural changes of intestinal mucosa, and performance of turkey poult infected with Salmonella and Campylobacter. S. Rahimi*, J. Grimes2, S. Kathariou2, and O. Fletcher2, 1Tarbiat Modares University, Tehran, Iran, 2North Carolina State University, Raleigh, NC.

The study was conducted to evaluate the effect of Calsporin, a probiotic or direct-fed microbial (DFM), and IMW50, a prebiotic mannanooligosaccharides (MOS) on performance, reduction of Salmonella and Campylobacter colonization in the digestive tract, intestinal histomorphology, and ultrastructural changes of intestinal mucosa in turkey poult. A 21 d battery cage study was conducted using 4 dietary treatments, including (1) a basal diet as negative control (NC); (2) the basal diet supplemented with 0.05% DFM; (3) the basal diet supplemented with 0.05% MOS; and (4) the basal diet supplemented with 0.05% mixture of DFM and MOS. Three hundred thirty-six day-old female Large White Turkey poult were randomly distributed in 6 electric heated battery cages with 12 treatments of 4 replicates per treatment containing 7 poult per pen. The first 16 pens were not infected with bacteria, poult in pens 17–32 were orally challenged at d 7 with 1 mL of 10^6 cfu/mL Salmonella Heidelberg, and the poult in pens 33–48 were orally challenged at d 7 with 1 mL of 10^5 cfu/mL Campylobacter jejuni. Feed intakes, body weight gain, and FCR were measured weekly and at the end of the experiment. At d 21, fresh fecal samples from each pen were collected for Salmonella Heidelberg and Campylobacter jejuni enumeration, and ileal tissue samples were collected from one bird per pen for histomorphometry and ultrastructural examination. Results showed significant increase of BW in both IMW and CSP treatments compared with control groups (P ≤ 0.05), also reduction of S. Heidelberg in fecal samples of poult with DFM and MOS (P < 0.05). Data also showed increased surface area of villi (66,599 vs. 59,247 µm^2; P < 0.05), increased length of villi (651 vs. 591 µm; P < 0.05) and increased number of goblet cells (825 vs. 754; P < 0.05). Electron micrographs showed higher number of segmented filamentous bacteria and more mucus secretion in DFM and MOS supplemented groups compared with control groups (P < 0.05). The results suggest that Calsporin and IMW50 enhance ileal mucosal health and performance of turkey poult.

Key Words: DFM, MOS, Salmonella, Campylobacter, turkey poult