
Synergistic effects of vitamin B1 (VitB1) on broiler carcass decontamination were evaluated during chilling in chlorinated and organic acids solutions. Live birds were purchased locally and processed at Michigan State University Meat Laboratory. In each of 3 replications, skin samples were taken from 5 prior-chill and 5 post-chill carcasses in 6 different chilling solutions prepared as follows: 1) 50 ppm chlorine, 2) 3% Optiform (sodium lactate and sodium diacetate), 3) 1.8% acetic acid (AA), 4) 25 ppm chlorine + 0.05% VitB1, 5) 1.5% Optiform + 0.05% VitB1, and 6) 0.9% AA + 0.05% VitB1. The initial pH of slurry chilling water significantly (P < 0.05) changed to 9.47, 5.91, and 2.65 when chlorine (50 ppm), Optiform (3%), and AA (1.8%) were added, respectively, which were changed again to 6.4, and 6.13, and 2.81 when VitB1 (0.05%) was mixed with half the 3 chemicals. The mean populations of mesophilic aerobic bacteria (MAB), E. coli and coliform on prior-chill carcasses were 4.39, 3.36 and 3.62 log cfu/g, respectively, all of which significantly (P < 0.05) reduced after chilling. No bacterial differences (P > 0.05) were seen between 2 groups of post-chill carcasses in the full single-chemical solutions and half-chemical/VitB1 solutions for MAB, E. coli and coliform, except E. coli and Coliform in AA solutions. These results indicate that 0.05% VitB1 addition to chilling water has the potential to reduce the chlorine level (50 ppm) by half or totally eliminate it via VitB1-organic acid mixtures.

Key Words: vitamin B1, chlorine free, organic acid, carcass decontamination, broiler chilling

Effects of increasing inclusions of camelina meal in broiler diets on tissue fatty acid composition. S. Nain*, M. A. Oryschak, M. Betti, and E. Beltranena

The human health benefits of consumption of n-3 (omega-3) polyunsaturated fatty acids (n-3 PUFA) have been recognized. Camelina sativa is a novel oilseed crop increasingly grown for biofuel use in marginal lands of the North American Plains. Its expeller meal with 10 to 20% residual cyanidins which have antimicrobial activity against other food borne pathogens including E. coli and Salmonella, but their activity against Campylobacter is unknown. The study objective was to evaluate, in vitro and in vivo, the efficacy of cranberry proanthocyanidins contained in frozen juice to reduce Campylobacter colonization in poultry. Funded in part by the USDA-NIFA-OREI 2011-01955.

Key Words: Campylobacter jejuni, probiotic, FOS, MOS, chicken
in 2 commercially available products. Proanthocyanidin levels in cranberry extract powders were determined by the supplier to be low (1%, L-PAC) or high (30%, H-PAC) of the total volume. In replicate in vitro trials, the lowest concentrations of L-PAC or H-PAC (0.1 or 0.5% wt/wt) did not reduce Campylobacter. A 1–5 log reduction at 1% (wt/vol) L-PAC or H-PAC was observed, and at 2 or 4% (wt/vol) there was a minimum 5 log reduction in Campylobacter. For in vivo studies, birds (n = 10/treatment) were given L-PAC or H-PAC at concentrations of 0.5, 1, or 2% (wt/wt) supplemented in the feed starting at day of hatch and continuing through d 14. At d 7, all birds were challenged with approximately 2.5 × 10^5 cfu/mL of Campylobacter jejuni by oral gavage and at d 14 birds were euthanized and cecal contents were collected for enumeration of Campylobacter. In both trials, cecal Campylobacter counts were not reduced by addition of L-PAC or H-PAC in the feed. Although highly effective in vitro, more evaluation is needed to determine optimum concentrations of cranberry proanthocyanidins to reduce Campylobacter in poultry.

Key Words: Campylobacter, cranberry, natural compound, poultry, food safety

68 Effect of dietary zinc supplementation on broiler performance and carcass yield. R. I. Qudsieh*, D. P. Smith, and J. Brake, Department of Poultry Science, North Carolina State University, Raleigh.

This study was conducted to evaluate the effect of feeding high levels of inorganic dietary zinc (Zn) on growth performance and carcass yield of broilers raised to 42 d. A total of 288 1-d-old male and female Ross 708 broilers were randomly distributed among 3 dietary treatments, with 12 replicate cages per treatment. Birds were fed diets containing 0, 120, or 240 mg Zn/kg diet. Body weight (BW) and feed intake (FI) were measured to calculate weight gain (BW gain) and feed conversion ratio (FCR). At 42 d, 3 birds per cage were weighed, stunned, exsanguinated, scalded, picked, eviscerated, and chilled. Chilled carcass weight without giblets (WOG) and carcass parts were measured. Dressing yield was calculated as WOG percentage of live weight. Parts yield was calculated as percentage of chilled WOG weight. Data were analyzed using GLM procedures of SAS. At 42 d, males consuming diets with 120 mg Zn/kg diet had higher BW and BW gain (P < 0.05), male BW was 2951, 3052, and 2905 g at 0, 120, and 240 mg Zn/kg diet, respectively. Female BW and BW gain were not affected by Zn. Males had greater FI (4332 vs. 3981 g) and improved FCR (1.42 vs. 1.47 g:g) compared with females from 1 to 42 d. Birds consuming diets supplemented with 120 mg Zn/kg diet had the best FCR (P < 0.01) with values being 1.46, 1.42, and 1.46 g:g for 0, 120, and 240 mg Zn/kg diets, respectively. Males had higher (P < 0.01) WOG compared with females with no diet effect. Males had larger (P < 0.01) breast fillet, tender, wing, leg, and thigh weights, however, as a percentage, males had higher leg (11.4 vs. 10.8%) and smaller wing (9.8 vs. 10.1%) percentages compared with females. Breast tender weight and percentage increased (P < 0.05) when dietary Zn was added. Breast tender weight was 101, 110, 110 g, and percentage was 4.7, 5.0, and 5.0% at 0, 120, and 240 mg Zn/kg diet, respectively. Results indicated that supplementing 120 mg Zn/diet improved FCR and breast tender size. Males and females differed in their performance and parts yields.

Key Words: dietary zinc, broiler, performance, carcass yield


Health agencies are advising people to increase consumption of the long chain (LC) n-3 fatty acids eicosapentaenoic acid (EPA) and docosahexaenoic acid (DHA). Flaxseed oil enriched in high stearidonic acid (SDA; 25%) and g-linolenic acid (GLA; 16%) content was compared with traditional flaxseed oil for its ability to contribute to increasing long chain (LC) n-3 polysaturated fatty acids (PUFA) in laying hens. Twenty-four individually caged White Leghorn laying hens (47 wk) were fed one of the 3 isocaloric and isonitrogenous diets for 21 d as follows: Control (basal diet + 4% corn oil), REGf (basal diet + 4% standard flax oil) or SDAf (basal diet + 4% SDA-enriched flax oil). At d 0, 7, 14 and 21, eggs from each hen were analyzed for fatty acids. After 21 d of feeding, liver, thigh, breast, heart, brain, abdominal fat pad and the rest of body were analyzed for fatty acid composition. Egg production, egg quality and hen BW were similar among treatments (P > 0.05). Egg yolk from SDAf-fed hens contained SDA at 0.27% of total fatty acids. The SDAf diet eggs also had an 8-fold increased yolk GLA. Both REGf and SDAf increased total egg n-3 PUFA compared with the Control diet (< 0.001). Although there was no difference in the total n-3 PUFA content between SDAf and REGf yolks, there was an increase of 56% in LC n-3 PUFA in yolks from hens fed SDAf compared with REGf. There was a 4.5 fold increase in eicosatetraenoic acid (EIA; 0.12% vs. 0.53%), a 1.5 fold increase in EPA (0.16% vs. 0.24%), and a 2.5 fold increase in docosapentaenoic acid (DPA) (0.13% vs. 0.29%) in SDAf compared with REGf yolk lipids. Feeding SDAf compared with REGf resulted in more LC n-3 PUFA deposition in heart (1.35 vs. 0.73%), breast muscle (1.78 vs. 1.34%) and in all other tissues tested except the abdominal fat pad. In the abdominal fat pad, LC n-3 PUFA were minimal, indicating that enrichment was likely in the phospholipids rather than in the triglycerides. These results suggest that SDA-enriched flaxseed can be used in layer diets to increase LC n-3 PUFA in eggs.

Key Words: egg, modified flax, n-3 polysaturated fatty acid, stearidonic acid, γ-linolenic acid

70 Reduction of Salmonella on turkey breast cutlets by plant-derived molecules—carvacrol, eugenol and trans-cinnamaldehyde. D. V. T. Nair* and C. S. Sharma, Mississippi State University, Mississippi State.

Non-typhoidal Salmonella spp. is the major bacterial causes of food-borne illnesses in the United States. Essential oils and their active compounds are well known for their antimicrobial activity. The objective of this study was to evaluate the antimicrobial efficacy of 3 plant-derived molecules: carvacrol, eugenol and trans-cinnamaldehyde in reducing Salmonella on fresh turkey breast cutlets. Turkey breast cutlets were inoculated with a 3-strain cocktail of Salmonella (S. Enteritidis ATCC 4931, S. Heidelberg ATCC 8326 and S. Typhimurium ATCC 14028) and treated with 0.5, 1, 2 and 5% (v/v) of carvacrol, eugenol and trans-cinnamaldehyde. Antimicrobial solutions were prepared in phosphate buffered saline (PBS) and applied as dip treatment for 2 min at 4°C. Positive (inoculated and treated with PBS) and negative (non-inoculated) controls were included in the study. After treatment, all the samples were stored at 4°C and analyzed after 24h. The effect of antimicrobial treatments on pH of turkey breast cutlets was also assessed. Duplicate
samples were used for each treatment and the experiments were repeated 3 times. Overall, all the treatments were effective in reducing *Salmonella* on turkey breasts cutlets ($P < 0.05$) as compared with positive control at 1, 2 and 5% concentrations. Dose dependent reduction of *Salmonella* was observed, even though none of the compound resulted in significant reduction when used at 0.5% concentration. Carvacrol was most effective in reducing *Salmonella* on cutlets with 0.9, 1.7, 2.6 log cfu/g reductions following 1, 2 and 5% treatments, respectively. Treating turkey breast cutlets with 1, 2 and 5% trans-cinnamaldehyde resulted in 0.9, 0.9, 2.3 log cfu/g reductions, respectively. Eugenol was least effective among 3 compounds tested in this study causing 0.8, 1.1, 1.0 log cfu/g reductions with 1, 2 and 5% treatments. There was no difference in pH of turkey breast cutlets among control and treatments. The effect of these plant-derived compounds on the organoleptic properties of poultry products needs to be studied for maximum consumer acceptance.

**Key Words:** essential oil, *Salmonella* spp., turkey breast cutlet

**71 Online and microbial surveys of the current practices for shell egg sanitation.** M. N. Al-Ajeeli*, C. D. Coufal, and C. A. Alvarardo, Texas A&M University, College Station.

Egg contamination and the subsequent recalls have become an important issue that can impact consumer’s concerns about shell egg safety. The objectives of this study were (1) to determine the current practices used in the industry for shell egg sanitation, and (2) to evaluate microbial loads on shell egg surfaces under the current sanitization practices. An online survey was developed to determine current egg sanitization methods used across the United States. The online survey included questions such as, facility location and size, egg shell color, shell egg sanitization chemicals, concentration, and sanitizer cost. A microbial survey was also conducted at 3 plants in Texas. Each plant was visited 3 different days. Ten eggs were aseptically collected for aerobic plate count (APC) enumeration at 3 points during processing: prewash, postwash, and post-sanitizer spray. Results from the online survey ($n = 82$) indicated that chlorine was the most used sanitizer (81.7%) followed by quaternary ammonium compounds (11%). UV light was the only sanitizer used by 4.9%, and 2.4% of the plants used more than 1 type of egg sanitizer. Also, results indicated that 63.4% produce white eggs, 4.9% were brown, and 31.7% processed both white and brown-shelled eggs. Facility types were 56.8% in-line, 17.3% off-line and 25.9% processed samples were used for each treatment and the experiments were repeated 3 times. Overall, all the treatments were effective in reducing *Salmonella* on turkey breasts cutlets ($P < 0.05$) as compared with positive control at 1, 2 and 5% concentrations. Dose dependent reduction of *Salmonella* was observed, even though none of the compound resulted in significant reduction when used at 0.5% concentration. Carvacrol was most effective in reducing *Salmonella* on cutlets with 0.9, 1.7, 2.6 log cfu/g reductions following 1, 2 and 5% treatments, respectively. Treating turkey breast cutlets with 1, 2 and 5% trans-cinnamaldehyde resulted in 0.9, 0.9, 2.3 log cfu/g reductions, respectively. Eugenol was least effective among 3 compounds tested in this study causing 0.8, 1.1, 1.0 log cfu/g reductions with 1, 2 and 5% treatments. There was no difference in pH of turkey breast cutlets among control and treatments. The effect of these plant-derived compounds on the organoleptic properties of poultry products needs to be studied for maximum consumer acceptance.

**Key Words:** essential oil, *Salmonella* spp., turkey breast cutlet


The efficacy of a GRAS-status, plant-derived compound, trans-cinnamaldehyde (TC), for reducing eggborne transmission of *Salmonella Enteritidis* (SE) and organ colonization in layer chickens was investigated in 2 separate trials using 24- and 40-wk-old birds. In each trial, 120 single-comb White Leghorn hens were randomly assigned to 6 treatments ($n$ = 20/treatment): a negative control (−ve SE, −ve TC), 2 compound controls (−ve SE, +ve 1% or 1.5% vol/wt TC), a positive control (+ve SE, −ve TC), a low dose treatment (+ve SE, +ve 1% TC) and a high dose treatment (+ve SE, +ve 1.5% TC). On d 0, birds were tested for any inherent *Salmonella* ($n$ = 5/experiment), and TC was supplemented in the feed at the aforementioned levels for 90 d. On d 14, birds in the positive controls, low dose and high dose treatments were challenged with SE (10 log$_{10}$ cfu/bird) by crop gavage. After 7 d of challenge, eggs were collected and examined for SE in the yolk and on the shell daily until the end of the trial. On d 90, 10 birds from each treatment were sacrificed to determine SE presence in the ceca, liver and oviduct. In both trials, TC supplementation at 1 and 1.5% decreased SE on shell and in the yolk ($P < 0.05$). Additionally, TC at both concentrations reduced SE in all 3 internal organs ($P < 0.05$) compared with control birds. Follow up mechanistic studies using cell culture and gene expression assays revealed that TC reduced SE adhesion and invasion of chicken oviduct epithelial cells, survival in chicken macrophages, and downregulated the expression of SE virulence genes critical for oviduct colonization ($P < 0.05$). No significant differences in egg production were observed among the different bird groups ($P > 0.05$). The results suggest that TC could potentially be used as a feed additive to reduce eggborne transmission of SE in layer chickens.

**Key Words:** *Salmonella*, egg, chicken, trans-cinnamaldehyde


Essential oils (EO) and their constituents are reported to possess potent antimicrobial activity, but their use in food processing is limited due to low solubility in aqueous systems and volatilization during processing. The objective of this study was to evaluate 2 non-commercial EO-containing encapsulated phosphate blends (EEOP) for antimicrobial activity against *Listeria monocytogenes* (LM) inoculated on 3 deli meats. Two trials of 4 treatments, EEOP-145 (T1, 0.45%) and EEOP-26 (T2, 0.6%) on chicken and pork; or EEOP-245 (T1, 0.45%) and EEOP-26 (T2) on beef, (percent of final product weight); a 2.0% potassium lactate control (PL, T3); and a negative control with no applied antimicrobial (NC, T4) were tested on a 25% added solution restructured pork ham formulated with 156 ppm of nitrite, a 25% added solution emulsified chicken bologna loaf (30% fat), and a 30% added solution restructured beef loaf. Products were formulated, manufactured, and cooked according to industry practices, and were stored at 4°C. Five, 12 g individual slices from each treatment were inoculated with 6.0 log$_{10}$ cfu/g of a 3-strain *Listeria* cocktail and individually bagged for sampling at 0, 7, 14, 21, 28, 35, 42, and 49 d. Results indicated that in pork, EEOP-26 and −145 did not significantly increase the lag phase but EEOP-26 was similar to PL and did decrease LM from d 21 through d 45. In chicken, EEOP-26 and −145 did not significantly increase the lag phase but EEOP-26 did decrease LM from d 30 through d 45 and was not significantly different from PL. In beef loaf, EEOP-26 did extend the lag phase by 7 d and was significantly similar to PL in LM decrease through d 45. In conclusion, EEOP −145 and EEOP-245 were not significantly different from the control and would not be a PL replacer. However, EEOP-26 can function to replace PL to inhibit *Listeria* growth in ready-to-eat (RTE) deli products.

**Key Words:** essential oil, phosphate, *Listeria*, potassium lactate, deli loaf

Human illness caused by *Salmonella* Enteritidis has been more frequently linked to the consumption of contaminated eggs than to any other food source. This pathogen can be deposited inside the edible contents of eggs when reproductive organs are colonized in systemically infected laying hens. In recent years, the animal welfare consequences of various housing systems for laying flocks have come under intense international scrutiny. However, the public health (food safety) implications of different laying hen production systems remain largely unresolved. The present study evaluated the effects of 2 types of housing (conventional cages and colony cages enriched with perching, nesting, and scratching areas) on *S*. Enteritidis invasion of internal organs in experimentally infected laying hens. In 2 trials, groups of laying hens housed in each cage system were orally inoculated with doses of 10⁷ cfu of *S*. Enteritidis. At 5–6 d post-inoculation, hens were euthanized and samples of internal organs were removed for bacteriologic culturing. *S*. Enteritidis was recovered from 95% of cecal samples, with no significant differences observed between housing systems. However, *S*. Enteritidis was detected at significantly (*P* < 0.05) higher frequencies from hens in conventional cages than from hens in enriched cages for samples of livers (97% vs. 75%), spleens (94% vs. 53%), ovaries (25% vs. 10%), and oviducts (20% vs. 2%). These results suggest that production systems for housing egg-laying flocks can influence the susceptibility of hens to internal organ colonization by *S*. Enteritidis.

**Key Words:** *Salmonella* Enteritidis, chicken, internal organ, conventional cage, enriched cage

Inhibition of *Salmonella* typhimurium by aerobic cecal flora of commercial broilers. A. Hinton Jr.* and K. D. Ingram, USDA-ARS, Athens, GA.

Ability of cecal microflora of broilers to inhibit growth of *Salmonella* was examined. Cecal cultures were prepared by collecting ceca of processed broilers from a commercial processing facility, inoculating broth media with 10 μL of cecal contents, and incubating media aerobically at 35°C for 48 h. Fresh bottles of media were inoculated with 0.1 mL of the cecal culture, 10⁶ cfu/mL of *Salmonella* Typhimurium, or the cecal culture and *Salmonella* Typhimurium. Aliquots of media were removed on d 0, 7, 14, and 21 for analysis during incubation at 35°C. Cecal bacteria and *Salmonella* were enumerated by incubating serial dilutions of samples on nonselective agar and Brilliant Green agar, respectively, and morphologically distinct cecal colonies were selected from agar and identified using the Biolog Bacterial Identification System. The pH of the samples was also measured. Results indicated that between d 0 and 7, there was a significant (*P* ≤ 0.05) increase in the number of colony-forming-units (cfu)/mL of *Salmonella* recovered from media inoculated with *Salmonella* only, but there was no significant increase in the number of *Salmonella* recovered from media inoculated with cecal cultures and *Salmonella*. Also, between d 7 and 21 there was a 4.89 log decrease in *Salmonella* recovered from media inoculated with cecal cultures and *Salmonella* while there was only a 1.79 log decrease in *Salmonella* recovered from media inoculated with *Salmonella* only. Furthermore, between d 7 and 21 there was a 1.70 and 1.71 log decrease in aerobes recovered from media inoculated with the cecal culture only and media inoculated with the cecal culture and *Salmonella*, respectively. There was also a significant increase in the pH of all inoculated media between d 0 and 21. *Proteus mirabilis* and *Enterococcus faecalis* were the predominant bacteria in the flora of cecal cultures. Findings indicate that cecal contents from processed broilers contain bacteria that can inhibit the growth of *Salmonella* Typhimurium. Understanding the anti-*Salmonella* activity of these bacteria may assist in identification of the components of effective probiotics.

**Key Words:** broiler, competitive inhibition, *Salmonella*, *Proteus*, *Enterococcus*