The impact of scalding and chilling profiles was evaluated on carcass and breast meat yield in broilers. On 4 separate weeks, 5 to 7 wk old broiler flocks were subjected to a 10 h feed withdrawal, cooped, transported, banded for identification, weighed (live weight), shackled, and then stunned (14.5 V DC, 500 Hz for 10 s) and bled (2 min) in 6 sequential batches (n = 16/batch). Weight selected broilers (within 300 g) were subjected to either hard (60°C for 1.5 min) or soft (52.8°C for 3 min) scalding (triple-tank, 740 L/tank). Following defeathering of the neck, shanks, viscera, and fat pad were removed and the carcasses were either air chilled (0.5°C, 120 min, 86% RH, air speed 76.2 m/min) breast-up on slotted metal shelves or immersion chilled in water and ice (79 L/carcass, 0.5°C, 40 min). Carcasses were weighed individually following evisceration and chilling. Breast meat (skinless, combined left and right fillets and tenders) was removed from the carcass and weighed within 4 h post mortem. Post-feed withdrawal mean live weight was between 2,601.0 and 2,642.4 g among the treatment groups and was 1,942.1, 2,471.2, 2,923.0, and 3,156.1 g for individual flocks. Post-scall defeathered-eviscerated carcass weight was 1% higher for soft-scalded carcasses (73.6%) than for hard scalded carcasses (72.6%). During air chilling carcasses lost weight resulting in post-chill carcass yield of 73% for soft-scalded and 71.3% for hard-scalded carcasses, a difference of 1.7%. During water chilling carcasses gained weight resulting in post-chill carcass yield of 78.2% for soft-scalded and 76.1% for hard-scalded carcasses, a difference of 2.1%. Breast meat yield was greater by 0.7% for soft-scalded carcasses (17.6% for air-chilled and 17.9% for water-chilled) than for hard-scalded carcasses (16.8% for air-chilled and 17.3% for water-chilled). Neither air nor water chilling treatments significantly influenced breast meat yield. Soft scalding carcasses resulted in a 1% higher post-scall-defeathered eviscerated carcass yield over that for hard scalding carcasses, which persisted following chilling as a small but significant 0.7% higher breast meat yield.

Key Words: scalding, chilling, processing, yield, broiler

Impact of carcass scalding and chilling methods on the functionality of early-deboned broiler breast fillets. H. Zhuang1, B. C. Bowker1, R. J. Buhr1, D. V. Bourassa1, and B. H. Kiepper2, USDA-ARS, Athens, GA, 2University of Georgia, Athens.

The impact of scalding and chilling methods on the functionality of early-deboned fillets (pectoralis major) was evaluated. In 3 replications, 5 to 7 wk old male broilers were slaughtered and scalded either at 60°C for 1.5 min (hard scalding) or 52.8°C for 3 min (soft scalding). Following evisceration, the carcasses were either air-chilled (0.5°C, 120 min, 86–90% RH, air speed 76.2 m/min) or immersion-chilled in water and ice (79 L/carcass, 0.5°C, 40 min, air agitated volume 3.89 M3/min). Breast fillets were removed from the carcass within 4 h postmortem. Boneless skinless fillet functionality color (lateral surface or skin side), pH, total moisture content, water-holding capacity (drip loss and cook yield), and Warner-Bratzler shear force were evaluated. No significant differences (P > 0.1) between the 2 scalding methods were observed for color, pH, moisture content, drip loss, and cook yield. However, the shear force (7.44 kgf) for hard-scalded fillets was higher (P = 0.06) than for soft-scalded fillets (6.67 kgf). These results suggest that even though hard and soft scalded fillets have the same surface appearance and water-holding capacity, scalding method may impact the texture of the early-deboned fillets. Immersion-chilled fillets had higher (P < 0.05) L* (59.3 vs. 56.7), pH (6.28 vs. 6.12), drip loss (2.1% vs. 1.7%), and shear force (7.65 kgf vs. 6.46 kgf), and lower (P < 0.05) cook yield (81.0% vs. 82.6%) and b* (7.46 vs. 8.51) than air-chilled fillets. These results suggest that immersion-chilled fillets are lighter and less yellow, lose more water during storage (higher drip loss) and cooking (lower cook yield), and require higher force to shear than air-chilled fillets. There were no interactions (P > 0.1) between chilling and scalding methods for any of the measurements, suggesting that the effects of scalding and chilling methods on fillet functionality are independent. The results of this experiment indicate that chilling methods have a greater impact on


The impact of broiler scalding method on the resulting processing wastewater stream was evaluated. On 3 separate days, 5 to 7 wk old broilers were subjected to a 10 h feed withdrawal, cooped, transported, weighed (live weight), shackled, and then stunned (14.5 V DC, 500 Hz for 10 s) and bled (2 min) in 6 sequential batches (n = 16/batch). Weight selected broilers (within 300 g) were subjected to either hard (60°C for 1.5 min) or soft (52.8°C for 3 min) scalding in a aerated 3-tank sequential configuration (740 L/tank). Prior to each scalding treatment, a 1 L sample of scald water was collected to determine potable water background values. Following the 3-batches for each scalding treatment, a 1 L sample of scald wastewater was collected from each of the 3 scalding tanks. All samples were stored at 4°C and analyzed for concentration (mg/L) of chemical oxygen demand (COD), total solids (TS) and total volatile solids (TVS). Resulting concentration data were used to calculate a corresponding wastewater loading value in grams per kilogram of live weight (g/kgwt). Post-feed withdrawal mean live weights for the 3 d were 2.924 kg (d 1), 1.942 kg (d 2), and 3.158 kg (d 3). The overall mean TS wastewater load produced during soft scald treatment (1.337 g/kgwt) was significantly (P ≤ 0.05) higher than hard scald (0.717 g/kgwt). The soft scald treatment also produced numerically but not significantly greater TVS (1.091 vs 0.609 g/kgwt) and COD (0.958 vs 0.755 g/kgwt) wastewater loading than hard scald. Scald tank position within the 3-tank sequence also had an impact on wastewater loading. In all treatments combined, the first scald tank had significantly (P ≤ 0.05) greater COD (0.551 g/kgwt) and TVS (0.492 g/kgwt) mean loading than the second and third scald tanks, which were not significantly different from each other. In terms of TS, the first scald tank loading (0.584 g/kgwt) was significantly greater than the third tank, but not the second scald tank. Results indicate that soft scalding of broilers (52.8°C for 3 min) has a greater impact on processing wastewater loading than hard scalding (60°C for 1.5 min).

Key Words: broiler processing, scalding, wastewater, COD, total solids

Impact of carcass scalding and chilling methods on the functionality of early-deboned broiler breast fillets. H. Zhuang1, B. C. Bowker1, R. J. Buhr1, D. V. Bourassa1, and B. H. Kiepper2, USDA-ARS, Athens, GA, 2University of Georgia, Athens.

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breast fillet functionality (color, pH, water-holding capacity, and shear) than scalding methods.

Key Words: broiler processing, scalding, chilling, breast fillet, functionality

71 Hot water spray on broiler carcasses reduced loosely, firmly, and internally attached pathogenic (Salmonella and Campylobacter) and mesophilic aerobic bacteria. P. Singh,* L. Zhang, H. C. Lee, and I. Kang, Michigan State University, East Lansing.

The objective of this study was to evaluate the efficacy of hot water spray (HWS, 70°C for 1 min) on microbial reduction of broiler carcasses. Live birds were purchased locally and processed at Michigan State University meat laboratory. In each of 4 replications, skin samples from 5 broilers were taken aseptically at each of 3 processing stages—after bleeding (feathers removed manually), after evisceration (with/without hot water spray), and after water chilling. Broiler skins were quantitatively examined for loosely (by rinsing the skin), firmly (by stomaching the rinsed skin) and internally attached (by grinding the rinsed/stomached skin) mesophilic aerobic bacteria (MAB), as well as for the prevalence of Salmonella and Campylobacter. The broiler skins with no HWS possessed the highest (>6 log cfu/g), the intermediate (3.8—4.1 log cfu/g) and the least (2.8—3.5 log cfu/g) MAB population after bleeding, evisceration and chilling, respectively. Comparing the status of MAB attachments after evisceration, the highest population (4.13 log cfu/g) was seen in the ground sample followed by the stomached (3.78 log cfu/g) and the rinsed (3.84 log cfu/g) skins. After the hot water spray and chilling, the population was reduced to 2.1, 2.0, and 1.7 log cfu/g for the ground, stomached, and rinsed skins, respectively. The incidence of Salmonella and Campylobacter was generally increased after evisceration and decreased after chilling. Again, the hot water spray reduced the incidence of Salmonella and Campylobacter by around 25—47% and 5—20%, respectively, regardless of pathogen-attachment status. However, the hot water resulted in a partially cooked appearance on the exposed breast. More research is required to eliminate the pathogenic organisms on carcasses, especially the internalized bacteria without apparent visual defects.

Key Words: broiler processing, hot water spray, microbial attachment, Salmonella, Campylobacter


The purpose of this study was to evaluate the cold-batter comminution technology on turkey processing efficacy and turkey breast functionality. In each of 3 replications, 15 turkeys were eviscerated and randomly assigned to one of 5 treatments: 1) chill-boned/comminuted-traditionally (CB-CT), 2) hot-boned/comminuted with no chill (HB-CNC), 3) hot-boned/comminuted with CO2 (HB-CCO2), 4) hot-boned/comminuted after crust-freezing-chill (HB-CCFC), and 5) hot-boned/comminuted after 1/4-crust-freezing-chill (HB-C1/4CFC). Turkey breasts were removed after-evisceration for hot boning (HB) or after-water-chill for chill boning (CB). For crust-freezing-chilling (CFC), HB breast halves, as a whole or in quarter portions, were subjected to a freezing room (−25°C). Right fillets were used for pH and R-value testing while remaining left fillets were comminuted under different temperature conditions. The resulting batters were subsequently cooked into gels. The pH and R-value of chilled meats, the pH of batters, and the cooking yield and stress/strain values of cooked gels were also tested. Data were evaluated using one-way ANOVA and Duncan’s multiple range test. The following results were found. The WC took an average of 5h to reduce the breast temperature to 4°C, while CFC and 1/4CFC took 1.5h and 1h, respectively. WC meat showed significantly lower pH and higher R-value compared with the HB and CFC meats. Likewise, WC batter had significantly lower pH values. All HB treatments showed significantly higher cooking yield over the WC, reflecting a better water holding capacity. All HB and cold batter comminuted gels had significantly higher values for stress (hardness) and strain (cohesiveness), indicating improved textural properties. Statistical significance was determined at P < 0.05. Based on these findings, the cold-batter-comminution of hot-boned turkey breasts can be used to improve protein functionality and meat turnover time in turkey processing.

Key Words: turkey breast, hot boning, cold batter mixing, protein functionality, meat turnover

73 Mixed-model analysis of Campylobacter occurrence on broiler carcasses at post-chill and prevalence at various sampling points in the production and processing continuum. K. L. Hataway*, R. H. Bailey†, J. A. Byrd‡, V. V. Volkova*, and R. W. Wills†, †College of Veterinary Medicine, Mississippi State University, Mississippi State; ‡SPARC, USDA ARS, College Station, TX; †Cornell University, Ithaca, NY.

Campylobacter is a leading cause of food-borne illness in the United States and poultry has been identified as a major reservoir. The purpose of this study was 2-fold: (1) to determine the grow-out and processing plant sample(s) that best predict the likelihood of Campylobacter presence on broilers at post-chill and (2) estimate the amount of variability in Campylobacter prevalence that is within the complex, farm, and flock levels. Sampling was conducted in 2 broiler companies located in the Southern United States, which encompassed 10 complexes, 32 farms, and 64 flocks. Upon the day of chick placement into the grow-out house the gastrointestinal tracts of chicks were collected from each flock. Prior to transportation to the processing plant and upon arrival at the processing plant, ceca, crop, and whole bird carcass rinses were collected. During processing, samples were collected before entering the immersion chill tank and again after exiting the immersion chill tank. Mixed-model logistic regression was used to assess the relationships between post-chill status and other sampling points. The best predictor of post chill Campylobacter carcass status was the exterior whole carcass sample in the grow-out environment before transportation. In the post-chill model, the percentage of variability in Campylobacter prevalence occurring at the complex, farm, and flock level were 8.6%, 72.8%, and 18.6%, respectively. The intra-class correlation for flocks within the same farm, flocks within the same complex but different farms, and farms within the same complex were 0.81, 0.09, and 0.11, respectively.

Key Words: Campylobacter, poultry, broiler, logistic regression, mixed-model
Contamination of eggs with *Salmonella* is a major health concern worldwide, since it can penetrate the shell and shell membranes, compromising egg safety when reaching the interior contents. Chemicals and mechanical washing methods are currently used to reduce contamination of eggs, while ultrasonication has been shown to reduce microbes. Experiments were conducted to determine the effect of 2 separate antimicrobials and ultrasonication on the survival of *Salmonella* after inoculation of the shell surface of table eggs. A naladixic acid-resistant *Salmonella* (10⁶ cells) was inoculated onto the egg surface using a droplet method. Antimicrobial treatment was performed with either hydrogen peroxide (H₂O₂) 1.5% or quaternary ammonium (QUAT) 0.031%, by immersion for 1 min and immersion plus sonication (SONIC) for 1 min. Control eggs were inoculated at the same time, then either immersed 1 min or immersed and sonicated 1 min in water to determine any rinsing effect. After the antimicrobial application, *Salmonella* was recovered from the eggshell and adhering membranes using aseptic shell crush techniques followed by serial dilutions and culturing on BG sulfa agar plates supplemented with 200 ppm of naladixic acid to identify only naladixic acid-resistant *Salmonella* would be recovered. Plates were incubated at 37°C for 24h and *Salmonella* colonies were counted. Data are reported as log cfu/mL. Means of *Salmonella* recovered (n = 2 eggs per treatment and 2 replicates of each treatment) were tested for significance (P < 0.05) with student’s t test. H₂O₂ significantly reduced *Salmonella* by 3.5 log compared with water control (log 4.01), while H₂O₂+SONIC reduced log count by 2.7 from water+SONIC control (log 4.23). QUAT, as compared with water control, reduced *Salmonella* numbers by 0.5 log, while QUAT+SONIC resulted in a 0.2 log reduction from water+SONIC control. These data suggest that there is a significant reduction in *Salmonella* contamination of eggs when using chemical antimicrobials, with hydrogen peroxide more effective than quaternary ammonium. Ultrasoundation did not contribute to any reduction of *Salmonella*.

**Key Words:** *Salmonella*, eggs, hydrogen peroxide, quaternary ammonium, ultrasonication

**75 Comparison of spray and immersion application of 1,3-dibromo-5,5-dimethylhydantoin against Campylobacter jejuni on poultry carcasses.** J. M. Smith*, M. Singh*, J. L. McReynolds*, and E. W. Limatt†, †Department of Poultry Science, Auburn University, Auburn, AL, †Elanco Food Solutions, Greenfield, IN, †Albemarle Corporation, Baton Rouge, LA.

Campylobacteriosis is one of the most common foodborne illnesses in the United States and is oftentimes attributed to poultry and its products. Antimicrobial interventions targeting *Campylobacter* spp. during poultry processing are essential, particularly because of current regulatory guidelines and ongoing efforts to control this pathogen. The objective of this study was to evaluate 2 different antimicrobial compounds, sodium hypochlorite and 1,3-Dibromo-5,5-Dimethylhydantoin (DBDMH) against *C. jejuni* on fresh poultry carcasses. Varying concentrations of DBDMH (0, 50, 75, 100, 200, and 300 ppm) and sodium hypochlorite (25, 50 ppm) were prepared and chilled to 10°C. Broiler carcasses were inoculated with 10 mL of *C. jejuni* (ca.7 log⁶ cfu/mL) and allowed 30 min for attachment followed by either immersion or spray treatments with the antimicrobial solutions for 60 and 120 s. Following treatment the carcasses were rinsed with 200 mL of Buffered Peptone Water and 250 µL of the rinsate was plated onto *Campylobacter* Cefex agar; and incubated under microaerophilic conditions at 42°C for 48h. Statistical analysis indicated that the immersion treatment provided the greatest reduction overall compared with the spray treatment (P ≤ 0.05), irrespective of time of exposure. Reductions were greater for DBDMH as compared with the sodium hypochlorite solution (P ≤ 0.05) at a concentration of 50 ppm. This study demonstrated that DBDMH is effective for short dwell time treatments to combat *C. jejuni* on fresh poultry suggesting its application in a finishing chiller during poultry processing.

**Key Words:** DBDMH, sodium hypochlorite, *Campylobacter*, processing

**76 Microbiological differences between laying hen strains housed in various production systems.** D. R. Jones*, K. E. Anderson†, J. Guard‡, and R. K. Gast*, †USDA Agricultural Research Service, Egg Safety and Quality Research Unit, Athens, GA, ‡North Carolina State University, Department of Poultry Science, Raleigh.

Sister flocks of 3 strains of laying hens were housed in conventional cage, free range, and cage free production systems. All flocks were located on a single, commercial-style research facility and provided the same dietary and lighting regimens. Once a season, a sample of shell eggs was aseptically collected from each production system and hen strain combination. In free range and cage free production, floor eggs were separated from nest box eggs. Cracked eggs were excluded from sampling. Shell emulsion pools were created and total aerobic, *Enterobacteriaceae*, and yeast and mold populations were enumerated. Total aerobic populations averaged between 3.5 – 4.5 log cfu/mL shell emulsion diluent for all strains across production systems. *Enterobacteriaceae* counts were lowest in winter for all strains and housing systems. Two strains had highest *Enterobacteriaceae* levels present in free range nest box eggs in the spring (3.8 – 4.2 log cfu/mL shell emulsion diluent). Yeast and mold counts were also lowest in the winter for all strain and housing combinations. Overall, average aerobic counts were similar between strains and housing systems. *Enterobacteriaceae* counts associated with egg shells were lowest for conventional cage production. Season of the year, hen production system, and laying hen strain all contribute to the overall microbial quality of shell eggs.

**Key Words:** alternative production, eggs, microbiology

**77 Effects of acid-adaptation on adhesion and invasion of INT 407 cells by Campylobacter jejuni.** G. Kumar-Phillips*, I. Hanning†, and M. Slavik‡, †University of Arkansas, Fayetteville, University of Tennessee, Knoxville.

The foodborne pathogen *Campylobacter jejuni* is one of the leading causes of human gastroenteritis. This bacterium is not a robust organism compared with many other foodborne pathogens and requires special conditions in the laboratory for its growth. In nature, however, this organism is able to survive in very diverse and hostile environments and produce disease in humans. The different mechanisms by which *C. jejuni* survives stressful conditions in the environment remain unclear. Adhesion and invasion are thought to be important factors for the colonization of *C. jejuni* in the intestinal tract of hosts. Previous research in our laboratory showed that *C. jejuni* has the ability to induce an adaptive tolerance response to stresses like acid and aerobic conditions. The aim
of this study was to determine the influence of acid adaptation on adhesion and invasion of human intestinal cells by *Campylobacter jejuni* strains (human and poultry) under different stress conditions. In our research, different human and poultry isolates of *C. jejuni* were exposed to an acid stress (pH 5.5) and further subjected to different stresses such as an acid pH of 4.5, starvation, and salt (3%). After exposure to the second stress, the adhesion and invasion abilities of the isolates were evaluated in vitro using an INT 407 cell line (human embryonic intestinal cells). All the experiments were performed in replicates of 3 and the results were analyzed using Student’s *t*-test. Acid-adapted *C. jejuni* showed an increase in adhesion and invasion when exposed to a pH of 4.5 compared with non-acid-adapted *C. jejuni* and also when exposed to starvation and 3% salt. The degree of adhesion and invasion varied with strains of *C. jejuni*, the time of adaptation to acid, as well as exposure time to the second stress. These data indicate that some stresses may increase the virulence of *C. jejuni*. Studies involving expression of virulence genes and stress-adaptation are now underway.

**Key Words:** *Campylobacter jejuni*, stress, acid-adaptation, adhesion, invasion

78 *Salmonella* Enteritidis deposition inside eggs after experimental infection of laying hens with different oral doses. R. K. Gast,* R. Guraya, and J. Guard, Egg Safety and Quality Research Unit, USDA-ARS, Athens, GA.

The continuing attribution of human *Salmonella* Enteritidis infections to internally contaminated eggs has necessitated the commitment of substantial public and private resources to risk reduction and testing programs for commercial laying flocks. Cost-effective risk reduction requires a detailed understanding of how *S. Enteritidis* infections in hens lead to pathogen deposition inside eggs. This study sought to resolve incompletely understood aspects of the relationship between *S. Enteritidis* oral exposure dose levels in experimentally infected laying hens and the frequency and location of subsequent egg contamination. In 2 trials, groups of specific-pathogen-free laying hens were experimentally infected with oral doses of 10⁴, 10⁵, or 10⁶ cfu of phage type 4 S. Enteritidis. Eggs were collected 5–23 d PI and cultured for *S. Enteritidis* contamination in yolk and albumen. Increasing inoculation doses caused significantly (*P* < 0.05) more frequent egg contamination and a significant shift in the location of deposition toward albumen contamination. *S. Enteritidis* contamination was detected in 0.9% of yolks and 0.2% of albumens after inoculation of hens with 10⁴ cfu, 4.0% of yolks and 1.7% of albumens following inoculation with 10⁵ cfu, and 6.5% of yolks and 10.8% of albumens after inoculation with 10⁶ cfu. These results demonstrate that oral exposure doses of *S. Enteritidis* for laying hens significantly affect important parameters of egg contamination which could potentially influence the effectiveness of risk reduction practices such as refrigeration.

**Key Words:** *Salmonella* Enteritidis, eggs

79 Food and environmental safety of pastured poultry processed on-farm and at a USDA-inspected facility in the southeastern United States. L. M. Trimble¹, M. E. Berrang², and W. Q. Alali¹, ¹Center for Food Safety, University of Georgia, ²USDA-ARS Russell Research Center, Athens, GA.

The primary objective of this study is to determine the food safety risk represented by pastured poultry products. This assessment is based on data collected from pastured poultry processing operations performed at the site of production (on-farm) and at a USDA-inspected slaughter facility. An assessment of the environmental impact of waste disposal practices from on-farm processing is also performed. Soil, compost, processing wastewater and carcass rinse samples are collected and assayed for *Salmonella* and *Campylobacter*. During the first 3 mo of this study, 4 visits have been made to a USDA-inspected facility that processes pastured poultry and 2 visits have been made to an on-farm processing operation in the southeastern United States. *Salmonella* and *Campylobacter* loads were determined using the Most Probable Number (MPN) method and the direct plate method, respectively. At the USDA-inspected facility, 83% (n = 40) of the carcass rinses were positive for *Salmonella* and 90% (n = 40) were positive for *Campylobacter*. The mean value for *Campylobacter* counts was 4.19 cfu/ml of rinse (95% CI: 0.47, 7.92). The mean value for *Salmonella* was 1.03 MPN/ml of rinse (95% CI: 0.22, 1.84). On the pastured poultry farm, 90% (n = 20) of the rinse samples were positive for *Campylobacter* and 90% were positive for *Salmonella*. The mean value for *Campylobacter* counts was 15.13 cfu/ml (95% CI: 7.35, 22.90) and the mean value for *Salmonella* was 2.13 MPN/ml of rinse (95% CI: 0.280, 3.98). The overall prevalence of *Salmonella* in environmental samples on this farm was 76% (n = 21) and a 92% (n = 12) prevalence for *Campylobacter*. The findings from this study suggest *Salmonella* populations in carcass rinses seem to be relatively similar for the USDA -Inspected Facility and the on-farm processor; whereas *Campylobacter* populations in carcass rinses is higher for the on-farm processor.

**Key Words:** *Salmonella*, *Campylobacter*, pastured poultry, on-farm processing, food safety