

## ABSTRACTS

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### SYMPOSIA AND ORAL SESSIONS

\*Author Presenting Paper

#### Processing and Products: Processing and Meat Quality

**6 Speciation of *Campylobacter* recovered at select points along the processing line during commercial turkey processing.** S. Stevens\*<sup>1</sup>, J. A. Byrd<sup>2</sup>, A. D. McElroy<sup>3</sup>, S. Anderson<sup>1</sup>, D. J. Nisbet<sup>2</sup>, D. J. Caldwell<sup>1</sup>, and M. E. Hume<sup>2</sup>, <sup>1</sup>Texas A&M University, College Station, <sup>2</sup>USDA-ARS Southern Plains Agricultural Research Center, College Station, Texas, <sup>3</sup>Virginia Tech, Blacksburg.

While both *Campylobacter coli* and *C. jejuni* are frequent causes of human campylobacteriosis, a common conclusion of health care professionals and researchers alike is that *C. jejuni* is the more pathogenic or virulent species. *C. jejuni* has been shown to be superior in enterotoxin production, suggesting that *C. jejuni* is more enterotoxigenic, and as such, potentially more virulent than *C. coli*. The objective of this investigation was to speciate *Campylobacter* isolates recovered in three commercial turkey processing facilities to either *C. coli* or *C. jejuni* using a PCR-based method of speciation. Carcass rinses were obtained from select points along the processing line within these three geographically distinct facilities at both pre-evisceration and post-evisceration sampling sites. Of all recovered *Campylobacter* evaluated across all plants, 93% were speciated to either *C. coli* or *C. jejuni*. When evaluating trends of individual species recovered among the three facilities, speciation of *Campylobacter* was variable depending on the location of sampling within each plant, and also between the facilities. *C. coli* was the predominant species isolated in Plants 1 and 3, representing 59% and 54% of total *Campylobacter* recovered by plant, respectively. Plant 2 had a higher incidence of *C. jejuni*, where this species represented 60% of total *Campylobacter* recovered. Although *C. jejuni* has historically been isolated at a higher frequency from cases of human campylobacteriosis, the present data do not consistently support a predominant trend of *C. jejuni* isolation from commercially processed turkeys.

**Key Words:** Turkeys, *Campylobacter*, Speciation

**7 Release of *E. coli* from feathered and featherless broiler carcasses immersed in warm water.** J. A. Cason\*, R. J. Buhr, and A. Hinton, Jr., USDA-ARS Russell Research Center, Athens, Georgia.

Release of bacteria from individual broiler carcasses in warm water was measured as a model of bacterial contamination of scald water. Immediately after

shackling and electrocution, feathered and genetically featherless broiler carcasses (n= 24 of each) were immersed individually in 42° C, air-agitated tap water for 150 seconds. Although any fecal material expelled during electrocution was removed, carcass condition was typical for market age broilers subjected to 12 hours of feed withdrawal. Duplicate water samples were taken at 10, 30, 70, 110, and 150 seconds and *E. coli* counts were determined. Samples of initial tap water and contaminated water approximately 2 minutes after removal of carcasses indicated that *E. coli* could not be detected in the original water source and that mortality of *E. coli* was negligible. Mean numbers of *E. coli* released were 5.3 and 4.7 log<sub>10</sub> (cfu/carcass) at 10 seconds and 6.2 and 5.5 log<sub>10</sub> (cfu/carcass) at 150 seconds for feathered and featherless carcasses, respectively. For both feathered and featherless carcasses, the rate of release of *E. coli* was highest in the first 10 seconds and the rate declined steadily during the remaining sampling period. This result is compatible with published reports of sampling of operating multiple-tank scalders indicating that a high proportion of total bacteria are in the first scald tank. Higher numbers of *E. coli* released from feathered carcasses were probably due to the much greater surface area of contaminated feathers compared to the skin of featherless carcasses.

**Key Words:** Broilers, *E. coli*, Scalding

**8 Poststun decapitation does not alter the number of bacteria recovered from broiler respiratory tracts following bleeding or immersion scalding.** R. J. Buhr\*<sup>1</sup>, M. E. Berrang<sup>1</sup>, D. V. Bourassa<sup>1,2</sup>, and J. A. Cason<sup>1</sup>, <sup>1</sup>USDA-ARS Russell Research Center, Athens, Georgia, <sup>2</sup>The University of Georgia, Athens.

Decapitation of broilers immediately following electrical stunning results in a rapid onset of death and eliminates the possibility of cadavers. These experiments compared the number of bacteria (*E. coli*, coliforms, and total aerobic) recovered from the respiratory tract of decapitated and conventional unilateral neck cut broiler carcasses following immersion scalding in a commercial plant. Heads were removed from stunned and bleeding carcasses as they exited the automated knife, by continuation of the bleed-cut. On each of three replicate sample days, 8 unilaterally bled and 8 decapitated carcasses were collected from the shackle line at the end of bleed-out and following triple-tank immersion

scalding. The trachea on each carcass was occluded with a cable tie around the neck, carcasses were individually bagged and transported to the lab. The trachea of each carcass was aseptically cannulated near the thoracic inlet and 60 mL PBS was introduced into the respiratory tract. Each carcass was inverted 30 times and respiratory tract rinses collected. As anticipated, scalding resulted in significantly higher numbers (by 1 to 2 Log<sub>10</sub> CFU) of *E. coli*, coliforms, and total aerobic bacteria in respiratory tracts rinses. However, the number of bacteria recovered from the respiratory tract rinse of decapitated carcasses was not different than that recovered from bled carcasses at either the pre or post-scald sample site. These results confirmed that bacteria numbers increase within the respiratory tract during immersion scalding. However, decapitation at the beginning of bleed-out does not influence the number of bacteria recovered following bleeding or following immersion scalding compared to unilaterally bled carcasses.

**Key Words:** Broiler, Immersion scalding, Respiratory tract bacteria

**9 Numbers and incidence of total aerobes, coliforms, *Escherichia coli*, and *Campylobacter* in contents from the crop and gizzard of broiler chickens.** D. P. Smith\* and M. E. Berrang, *USDA-ARS Russell Research Center, Athens, Georgia.*

During processing the crop or gizzard of broiler chickens may be damaged, allowing contents to contaminate the carcass. The USDA FSIS defines contents from either organ as ingesta. Previous research has shown that crop contents are a source of *Salmonella* contamination on processed carcasses, although much less is known about gizzard contents. The purpose of this study was to determine the numbers of total aerobic bacteria, coliforms, *E. coli*, and *Campylobacter* present in crop and gizzard contents. In each of three replicate trials, 10 unviscerated broiler carcasses were obtained from a commercial processor just prior to evisceration. Liquid crop contents and solid gizzard contents were aseptically collected from each carcass and plated following serial dilutions. Total aerobic bacteria, coliforms, *E. coli*, and *Campylobacter* numbers were determined for contents from both organs and reported as log CFU/ml for crop contents and log CFU/g for gizzard contents. The crop contents, as compared to gizzard contents, contained significantly ( $P < 0.05$ ) higher numbers of total aerobic bacteria (5.6 vs. 2.9), coliforms (4.2 vs. 2.3), *E. coli* (3.9 vs. 2.2), and *Campylobacter* (4.6 vs. 2.2), respectively. *E. coli* incidence was also higher for crop content samples vs. gizzard content samples (28/29 vs. 19/30, respectively, positive samples/total samples). There was also a higher incidence of *Campylobacter* in crop samples as compared to gizzard samples (29/29 vs. 12/30, respectively). Liquid crop contents, although difficult to visually detect on carcasses, could contribute to increased numbers and higher incidence levels of *E. coli* and *Campylobacter*. Visible ingesta from the gizzard would contribute considerably fewer numbers of bacteria and less *E. coli* and *Campylobacter* contamination on the carcass.

**Key Words:** Ingesta contamination, Crop and gizzard, *E. coli* and *Campylobacter*

**10 Relative resistance of bacteria associated with poultry processing to the antibacterial activity of electrolyzed water.** A. Hinton Jr. \*<sup>1</sup>, V. K. Burkeen<sup>2</sup>, and Y. Hung<sup>2</sup>, <sup>1</sup>*USDA-ARS Russell Research Center, Athens, Georgia,* <sup>2</sup>*University of Georgia, Athens.*

*In vitro* studies were conducted to determine the ability of electrolyzed (EO) water to reduce populations of bacteria associated with poultry processing. EO water was generated using a ROX Water Electrolyzer and 10% solutions of sodium chloride (NaCl), potassium chloride (KCl), or magnesium chloride (MgCl<sub>2</sub>). Acidic fractions of EO water containing approximately 1 ppm of free chlorine were collected, and 20, 40 or 60% (v/v) EO water solutions were prepared by diluting EO water with distilled water. Solutions were analyzed to determine the pH, oxidation-reduction potential (ORP), and concentration of free and total chlorine. *Campylobacter jejuni*, *Escherichia coli*, *Listeria monocytogenes*, and *Salmonella* Typhimurium cultures were suspended in separate aliquots of distilled water or EO solutions for 30 sec. Portions of bacterial suspensions in EO water were then transferred to neutralizing buffer, and viable bacteria were enumerated by direct plating onto agar media. Enrichment procedures were used to detect viable bacteria present in numbers too low to be de-

ected by plating. Results indicated that there was no significant ( $p < 0.05$ ) difference in the free chlorine concentration, total chlorine concentration, pH, or ORP of EO water prepared using either salt. Additionally, EO water generated using either salt significantly reduced the number of viable bacteria recovered from EO water. The degree of resistance to the antibacterial activity of EO water was *C. jejuni* > *L. monocytogenes* > *Salmonella* Typhimurium > *E. coli*. Findings demonstrate that NaCl, KCl, or MgCl<sub>2</sub> may be used to prepare bactericidal, acidic EO water and that these solutions can be used to kill several bacteria associated with poultry processing.

**Key Words:** Electrolyzed water, Chlorine concentration, Bactericidal

**11 Impact of post-chill dip application of acidified sodium chlorite on the shelf life of commercial broiler carcasses.** O. A. Oyarzabal\*<sup>1</sup>, D. E. Conner<sup>1</sup>, C. C. Warf<sup>2</sup>, and G. K. Kemp<sup>2</sup>, <sup>1</sup>*Auburn University, Auburn, Alabama,* <sup>2</sup>*Ecolab, Redmond, Washington.*

Forty post-chill carcasses (control) and 40 post-chill carcasses treated with a dip bath of acidified sodium chlorite (ASC, SANOVA®) were collected from a commercial broiler processing plant, iced and shipped to a third-party laboratory and stored at 4°C. At the same time, eight carcass rinse samples were collected post-chill for determination of background microflora (day 0). Refrigerated carcasses were sampled at 5, 8, 12, 15, and 18 days of storage. Light signs of spoilage (smell and color) were noticed at day 15. Eight carcasses from each treatment group were sampled in each of the sample days using the carcass rinse method. Each rinse sample was analyzed for aerobic plate count (PCA, 37°C for 24 h), lactic acid bacteria (LAB, 37°C anaerobically for 24 h), Pseudomonas count (30°C for 48 h) and psychrotroph count (10°C for 7 days). All bacterial counts were converted to log<sub>10</sub> CFU/mL and an analysis of variance performed. PCA results showed a difference between post-chill and post-ASC treatment up to day 8. After that, the difference between the treated and control group disappeared. There were no differences up to day 8 between control and treated groups for LAB. However, on days 12 and 15, ASC-treated carcasses showed a lower level of LAB. Pseudomonas and psychrotroph count did not exhibit any significant variation between treated and control groups for each sampling day. Post-chill applications of ASC helped reduce the initial PCA load of poultry carcasses. A post-chill application of ASC may further increase microbial shelf-life over that of a pre-chill application.

**Key Words:** Acidified sodium chlorite, Poultry, Shelf life

**12 Effect of lighting intensity and duration on breast fillet dimensions and meat quality.** N. A. McKee\*, R. J. Lien, J. B. Hess, S. F. Bilgili, and S. R. McKee, *Auburn University, Auburn, Alabama.*

This study was conducted to investigate the effect of lighting intensity and lighting periods on growth and meat quality factors. Ross 708 broilers (total n=1200) were housed in light-tight rooms and subjected to lighting treatment of either, bright (1.0 foot-candles) or dim (0.1 foot-candles). Within these lighting treatments, birds were further divided into 2 lighting periods which is long (23L:1D) and short (8L:16D). Birds were reared to 49 d of age. After birds were processed and chilled, a sample of 192 birds (two replications, which equaled to 24 birds/treatment/replication) were deboned at 2 h PM. Filet weights, filet dimensions (length, width, and height), pH, color, cook-loss and shear values were evaluated. As controls, filets from 96 birds from bright and long lighting (BL) and dim and long lighting (DL) were deboned at 4 h PM, then cooked and subjected to shear value analysis. Live weights of birds exposed to BL and dim short (DS) treatments were higher than those birds under bright short (BS) and DL treatments. Filets weights of birds from BL treatment were higher than any other treatments ( $P < 0.05$ ). The increase in filet weights observed was likely due to an observed increase in filet width, height and area of filets. There was no significant difference in percent yield, cook loss, color (L, a, and b- value) and pH regardless of lighting treatments. Filets deboned at 2 h PM had higher shear values than those deboned at 4 h PM, regardless of lighting treatment. Furthermore, there were no differences in shear values based on light intensity or duration within each deboning period. In conclusion, bright and long lighting (BL) treatment resulted in greater filet weights and filet dimensions.

**Key Words:** Lighting, Meat quality, Tenderness

**13 Effect of chronic heat stress on meat quality parameters of two commercial broiler lines.** A. Saha<sup>\*1</sup>, T. L. Wing<sup>2</sup>, and C. M. Owens<sup>1</sup>, <sup>1</sup>University of Arkansas, Fayetteville, <sup>2</sup>Cobb-Vantress, Inc., Siloam Springs, Arkansas.

Heat stress (HS) is an important stressor and has been related to the development of PSE meat in poultry. The purpose of this study was to evaluate the effects on meat quality parameters due to chronic heat stress on two commercial broiler lines, one selected for traditional broiler traits (line A) and the other with more emphasis on reproductive traits (line B). At 28 d of age, birds were exposed to 37°C for 4 wks. The control and HS birds were processed at 56 and 59 d. Breast muscle samples were taken at .25, 1.5, 3, 4 & 24 h PM for pH and 4h for expressible moisture (EM). The right breast was deboned at 4h and evaluated for color (L\* value), moisture, cook loss, tenderness (total energy and force) and marination properties. There was a significant HS effect in the means for live weight of both the lines with HS birds having a lower live weight when compared to control birds. Line A birds were significantly heavier than Line B in both controls and HS. Muscle pH decline was more affected by HS in the A line indicated by significantly lower pH at 0.25 h and 3 h PM compared to the control. However, no significant differences were observed in the B line early postmortem. Heat stress caused higher L\* values in breast fillets at 4 h PM (line A & B) and 24 h PM (line A). Breast fillets for HS birds had significantly higher mean values for drip loss and lower mean values for moisture %, total energy and force as compared to the control fillets. The HS birds had higher EM compared to the control birds. HS resulted in higher cook losses compared to controls in non-marinated fillets; however, with marination, cook losses were significantly reduced in the HS birds (both lines) and in the control (line A), thereby improving yield. The data suggest that elevated environmental temperatures (heat stress) can induce conditions resulting in reduced meat quality of broilers.

**Key Words:** Heat stress, pH, Color

**14 Supplementing peanut skins in poultry diets to alleviate meat quality defects associated with heat stress.** L. J. Bauermeister<sup>\*1</sup>, C. Z. Alvarado<sup>2</sup>, and S. R. McKee<sup>1</sup>, <sup>1</sup>Auburn University, Auburn, Alabama, <sup>2</sup>Texas Tech University, Lubbock.

Peanut skins have high levels of antioxidants and are a natural by-product of the peanut processing industry. This study was designed to determine the effect diets supplemented with peanut skins to alleviate meat quality defects associated with heat stress. Day-old chicks (n=400) were randomly placed in pens and fed either a commercial ration (control) or a commercial ration supplemented with 5% peanut skins (supplemented). At 4 weeks of age, half of the broilers in the control group and half of the broilers in the supplemented group were subjected to heat stress (HS) temperatures of 32/38 C (night/day) while the remaining birds were reared at ambient temperatures. The treatment designations were as follows: ambient temperature, peanut skin supplementation (CP), ambient temperature, regular diet (CR), heat stress, peanut skin supplementation (HP), heat stress, regular diet (HR). Broilers (n=400) were conventionally processed at 6 weeks of age. Live weight and carcass weights were recorded. Breast fillets (n=400) were deboned at 4 hours and pH and Hunter L\*a\*b\* values were determined. Samples were pooled for each treatment group and deli loaves (n = 4 trts x 5 loaves) were formed. In addition, gel strength, shear value, cook-loss and Texture Profile Analysis were evaluated for each deli loaf. Regardless of peanut skin supplementation, birds subjected to HS had lower live and carcass weights compared to birds reared at ambient temperatures (control). Within the control group, birds fed diets supplemented with peanut skins had lower live and carcass weights compared to non-supplemented birds. L-value results suggested the following trend (HR>HP>CR>CP) with higher L-values indicating paler fillets. Deli loaf measurements indicated lower shear values, gel strengths and hardness in deli loaves in the HS treatments compared to controls. Peanut skin had no affect on shear values, deli loaf hardness or other deli loaf characteristics. This study suggests that diets supplemented with 5% peanut skins may alleviate some of the meat quality defects associated with heat stress.

**Key Words:** Heat stress, Peanut skins, Meat quality

**15 Impact of alternative broiler genotype and production system on meat quality.** A. C. Fanatico<sup>\*</sup>, P. B. Pillai, J. L. Emmert, and C. M. Owens, University of Arkansas, Fayetteville.

Consumer interest in natural and organic poultry is growing. An experiment was conducted to assess the impact of alternative genotypes and production systems on meat quality. A slow-growing genotype (S) and a commercial fast-growing genotype (F) (all females) were raised for 91 and 63 days, respectively. The placement dates were staggered in order to achieve a similar final body weight and each genotype was processed on the same day. Each genotype was assigned to four pens of 20 birds each and raised in indoor floor pens in a naturally ventilated facility; each genotype was also assigned to four floor pens in a small portable facility with outdoor access (during daylight hours). The birds were fed diets formulated to be low in energy and protein for a slower rate of production as in the French Label Rouge program. Birds were commercially processed and deboned at 4 h postmortem. The F birds gained more weight than the S birds (P < 0.05) even though they were placed 4 weeks later. An interaction was evident in which the meat and skin of the S birds became more yellow (higher b\*) when the birds had outdoor access; however, this did not occur when the F birds had outdoor access (P < 0.05). The redness of breast meat was affected by strain with the F birds being more red (higher a\*) than the S birds (P < 0.05). The breast meat of the S birds had more protein (P < 0.05) and less fat than the F birds, with only one half the amount of fat of the F birds (P < 0.05). Production system had an impact on protein, with the outdoor birds having more protein than the indoor birds (P < 0.05). The S birds were more tender than the F birds (P < 0.05). There was no effect of genotype or production system on drip loss (P > 0.05). These data indicate that meat quality differences may exist among genotypes with different growth rates and reared in alternative production systems.

**Key Words:** Broiler, Organic, Meat quality

**16 A comparison of carcass characteristics and fillet uniformity among four commercial broiler crosses marketed at 6 and 8 weeks of age.** N. S. Joseph<sup>\*</sup>, J. Lee, E. T. Moran, Jr., and J. Galobart Cots, Auburn University, Auburn, Alabama.

Fillet weight and/or dimensions of length, width, and depth may differ among strain crosses with age since various selection strategies are employed to improve their yield. This study compared the carcass and fillet characteristics of four commercial strain crosses at 6 and 8 weeks of age. Male and female broilers from each strain (A, B, C, and D) were housed, sex-separate, in floor pens (40 chicks/pen). Birds were on-line processed at either 6 or 8 wk of age. Carcasses were slush-ice chilled and deboned at 24 h post-mortem by experienced personnel. Dimensions were determined at the longest, widest, and thickest points on the fillet originating from the right side of the carcass.

Strains A, C, and D exhibited heavier body weights over Strain B, respective of sex, at both 6 and 8 wk of age. All strain crosses had similar feed conversion and mortality losses. Compared to females, males had a lower feed conversion and higher mortality due to sudden death syndrome and/or ascites. Carcasses from Strains A, C, and D weighed more than carcasses from Strain B at both ages, but only those from Strains C and D represented a greater proportion of their live weight. Whole fillet yield was greater for Strains B, C, and D at 6 wk of age compared to Strain A, and remained high for Strains B and D at 8 wk of age. Right fillets from Strain D weighed more on an absolute basis, had a reduced length, and were thicker than fillets from Strain A. Strain B fillets were of similar weight, length and depth to those of Strain D but not as wide, while Strain C fillets were intermediary in all respects. Males had a distinct advantage over females in fillet weight that was accompanied by an increase in all dimensions. Since broiler strain differences in fillet weight were not proportional to their dimensions, improved portion control could be achieved by separating fillets based on both weight and dimensional characteristics.

**Key Words:** Strain cross, Age, Breast fillet

**17 Marination of turkey breast fillets with organic acids to control the growth of *Listeria monocytogenes* and improve meat quality.** C. D. Carroll\*, C. Z. Alvarado, M. M. Brashears, and L. D. Thompson, *Texas Tech University, Lubbock*.

Turkey deli loaves were evaluated using organic marinades in the raw product to control the growth of *Listeria monocytogenes* and improve meat quality in the cooked product. Turkey lobes were obtained from a commercial processor at 24 h post mortem, divided into 5 treatments including STP (0.45%, control), sodium lactate (3%), sodium diacetate (0.25%), sodium citrate (0.75%), and sodium lactate (3%)/sodium diacetate(0.25%) combination, all containing 1.5% salt. Each treatment was chunked and vacuum tumbled (18 in Hg, 1 h, 14 RPM, 4 C) separately in 20% wt/wt marinade, formed into deli loaves and cooked. Data collected in 2 trials included pH, Hunter L\* a\* b\*, marinade pickup % and marinade retention %, bindability, cooked meat moisture, TBARS, APC (Day 0-80) and sensory evaluation. Thirty-two slices from each loaf were inoculated with a 10<sup>3</sup> surface inoculum of Streptomycin-resistant *Listeria monocytogenes* cocktail and analyzed (Day 0-77). pH and color were not significantly different for any treatment before marination, and post-marination a\* and b\* values were not different. pH values from the sodium lactate treatments were significantly lower (5.84) from the other treatments post-marination. Post-marination L\* from the sodium diacetate (47.49) loaves were significantly higher than the lactate (44.61) and citrate (46.71) treated loaves. Bindability was significantly higher in the STP (0.503N) and diacetate (0.408N) treatments when compared to the others treatments. The STP loaves had > 10<sup>6</sup> cfu/mL APC by day 14, sodium lactate by day 20, sodium citrate by day 40, sodium diacetate by day 70, and sodium diacetate/sodium lactate by day 74. A trained sensory panel evaluated the deli loaves three days after processing and 50% preferred the sodium lactate/sodium diacetate combination. Sodium diacetate, citrate, and lactate/diacetate all extended the lag phase of *Listeria monocytogenes*. Therefore, acidic marinades applied in the raw product do have a negative effect on some cooked product quality but improve shelf-life and decrease LM growth by extending the lag phase.

**Key Words:** Marination, Turkey, *Listeria monocytogenes*

**18 Performance evaluation of a model to predict growth of *Clostridium perfringens* in cured and uncured injected turkey during exponential cooling.** M. X. Sanchez-Plata<sup>\*1,2</sup>, A. Amezcua<sup>2</sup>, and H. Thippareddi<sup>2</sup>, <sup>1</sup>Texas A&M University, College Station, <sup>2</sup>University of Nebraska, Lincoln.

Predictive models to describe germination and outgrowth of *Clostridium perfringens* spores during exponential cooling of processed turkey products were developed and validated. Isothermal growth of *C. perfringens* was determined at fifteen different constant temperatures (from 10 to 47°C) in commercially formulated cured and non-cured injected turkey. Turkey breasts were injected with marinade formulations (1% salt, 0.2% potassium tetrapyrophosphate and 0.2% starch) supplemented with and without curing ingredients. The ground product was inoculated with a three-strain cocktail of *C. perfringens* spores (NCTC 8238, 8239 and ATCC 10388), mixed, vacuum packaged and thermally processed under simulated commercial cooking conditions. Primary modeling was achieved by fitting experimental data to the Baranyi's non-autonomous differential equation. Growth kinetic parameters for *C. perfringens* outgrowth under isothermal conditions were determined. The square-root Ratkowsky equation was used for secondary modeling to describe *C. perfringens* growth as a function of temperature change (dynamic cooling). The first order differential equations derived from primary and secondary models were solved using the fourth-order Runge-Kutta method. *C. perfringens* spores were able to germinate and grow from an initial population of ca. 3.0 log CFU/g by 2.4, 3.3, 3.9, 5.5 and 5.7 log CFU/g in un-cured samples subsequent to 9, 12, 15, 18 and 21 h exponential chill rates, respectively. Outgrowth in cured samples was 1.5, 2.9, 3.1, 4.8 and 5.9 log CFU/g after 12, 15, 18, 21 and 24 h of exponential chilling. In general, the *C. perfringens* predictive model for non-cured turkey accurately predicted growth from spore inocula during exponential cooling. The model for cured turkey tends to overpredict ("fail-safe") in some of the validation trials. The use of these equations in commercial settings will enable processors and regulators to evaluate safety of commercially produced cured and non-cured injected turkey products.

**Key Words:** *Clostridium perfringens*, Predictive modeling, Performance standards

**19 Bone strength of clavicles from four commercial high yielding broiler strains.** J. M. Mehaffey\*, A. Saha, J. F. Meullenet, and C. M. Owens, *University of Arkansas, Fayetteville*.

Bone fragments including the clavicle and fan bone are a major concern in the production of boneless breast meat. Clavicles can often break at various points throughout the processing scheme and it is these broken bones which can cause problems for the industry. Therefore, the purpose of this study was to evaluate bone strength and other bone quality parameters of broilers from high yielding strains. Commercial broilers (n=277) representing four high yielding commercial strains, males and females, were processed at seven weeks of age using an in-line system. The clavicles were collected from the birds at time of deboning (approximately 30 min postmortem), packaged and held at 4 C until time of evaluation of bone diameter and strength. Intact clavicles (at time of collections) were broken by pulling the clavicle apart (tension test) measuring force and energy. These bones, in addition to the bones that were previously broken during processing, were broken by using a 3 point bend breaking method on one side of the clavicle. At time of collection, 44.77% of the clavicles were broken (pre-broken) due to processing. Results of the 3 point bend test indicated that the pre-broken bones were significantly weaker and smaller in diameter than those left intact throughout processing. Males had stronger bones than females as indicated by higher force values for both the tension and 3 point bend test and higher energy (tension test). Males also had clavicles with larger diameters than females. There were no overall differences in bone strength due to strain alone. Bone strength and diameter were moderately correlated (r=0.42, p=0.0001). These results suggest that gender and bone diameter influenced clavicle bone strength more than a strain effect. Future research should focus on techniques to improve clavicle bone quality.

**Key Words:** Bone strength, Strain, Clavicles

**20 Effect of nisin carry over into the plating medium on *Listeria monocytogenes* enumeration and efficacy of chymotrypsin for inactivation of nisin on ready to eat meat surfaces.** S. Mangalassary\*, I. Y. Han, and P. L. Dawson, *Clemson University, Clemson, South Carolina*.

Validation studies for use of an antimicrobial agent may overestimate inhibition due to carry over of the antimicrobial into the enumeration medium. Three sets of experiments were carried out to evaluate this effect with nisin. First, application of different nisin solutions (0, 100, 250, 1000 IU) to ready to eat turkey bologna surfaces, on the survival of *Listeria monocytogenes* (LM) was measured. A second experiment was conducted to evaluate the effect of residual nisin concentration incorporated into the enumeration medium on the survival of LM and a third experiment assessed the efficacy of  $\alpha$  chymotrypsin to inactivate nisin on bologna surfaces. In the first experiment, bologna surfaces treated with different concentrations of nisin were inoculated with LM suspension and enumerated. In the second experiment, LM was added directly to nisin solutions (20, 50, 100, 200, 500 IU/ml) and plated. In the third experiment, bologna surfaces were exposed to a control (no nisin or chymotrypsin), nisin+chymotrypsin, nisin, and chymotrypsin solutions, surface inoculated with LM and plated. Application of nisin solutions on bologna surfaces affected LM survival. Experiment found that only >100 IU/ml of nisin incorporated into the plating medium significantly affected the survival of LM. In the third experiment, there was no significant difference in LM counts between chymotrypsin treated nisin sample and control indicating nisin inactivation. Results from this study indicate that the effect of residual nisin on the survival of LM is a factor to be considered only if the initial concentration of nisin used on meat surface is high enough to result in carry over of significant nisin activity (>100 IU/ml) to the plating medium after serial dilutions. Results also showed that  $\alpha$  chymotrypsin is effective to inactivate nisin before recovery in meat products. Antimicrobial activity carry over into the enumeration step of intervention studies should be considered when validating a LM inhibition for ready to eat meats.

**Key Words:** Nisin, *Listeria monocytogenes*, Turkey bologna

**21 Organization of a NAFSS-ARS cooperative research project to quantify *Listeria monocytogenes* in ready-to-eat meats and poultry products.** O. A. Oyarzabal<sup>\*1</sup>, A. Draughon<sup>2</sup>, E. T. Ryser<sup>3</sup>, D. Cliver<sup>4</sup>, M. Hajmeer<sup>4</sup>, P. Pangloli<sup>2</sup>, and R. Roy<sup>1</sup>, <sup>1</sup>Auburn University, Auburn, Alabama, <sup>2</sup>University of Tennessee, Knoxville, <sup>3</sup>Michigan State University, East Lansing, <sup>4</sup>University of California, Davis.

The objective of this cooperative research project is to quantify *Listeria monocytogenes* in ready-to-eat (RTE) uncured and cured poultry, pork and beef products that have been pre-sliced by the manufacturer or sliced upon demand in supermarket delis. This data will expand on a previous study sponsored by the Food Products Association (formerly National Food Processors Association; Gombas et al., 2003, J. Food Prot., 66:559) which compared the risk of listeriosis to consumers from RTE products sliced at retail stores versus the risk from products sliced and packaged by the manufacturer. This is an ongoing

study in which four states participating in the Foodborne Diseases Active Surveillance Network of the Centers for Disease Controls and Prevention Emerging Infections Program have been selected as collection sites: California Bay Area, Georgia, Minnesota and Tennessee. Samples are collected weekly from randomly selected counties and processed within 36 hours of collection. Samples positive for *L. monocytogenes* are quantitatively assessed using a standard 3-tube MPN. Data from this study will be used to estimate actual consumer exposure to *L. monocytogenes* from the sampled RTE products, and to conduct additional *L. monocytogenes* risk assessments. The importance of cooperation between industry, academia and the Food Safety and Inspection Services of the US Department of Agriculture in performing this kind of research will also be discussed.

**Key Words:** *Listeria monocytogenes*, Ready-to-eat, Poultry

## Environment and Management: Broiler Breeders

**22 Phosphorus nutrition in broiler breeder pullets and hens.** M. S. Lilburn<sup>\*1</sup>, A. Mitchell<sup>2</sup>, and E. E. M. Pierson<sup>3</sup>, <sup>1</sup>Ohio State University, Wooster, <sup>2</sup>Growth Biology Lab, USDA, Beltsville, Maryland, <sup>3</sup>Danisco Animal Nutrition, St. Louis, Missouri.

Two experiments were conducted with growing broiler breeder pullets (Experiment 1) and growing pullets and adult breeder hens (Experiment 2). In Experiment 1, pullets were fed growing diets with either 0.8 or 1.0% calcium and either 0.2, 0.3, or 0.4 % available phosphorus (all diets contained between 0.5-0.6% analyzed total phosphorus).

At 8 weeks of age, 8 pullets from each combination of Ca and AvP were placed in individual cages within Petersime growing batteries. Each pullet was fed 86 gm on alternate days (EOD) and total excreta was collected for 48 h. This was repeated twice. There were no significant effects of dietary Ca on P excretion. There was a linear increase in mean total excreta P with each increase in AvP (231 mg P, 0.2 AvP; 305 mg P, 0.3 AvP; 377 mg P, 0.4 AvP). In Experiment 2, pullets were fed diets containing 0.15, 0.25, or 0.35% AvP with and without supplemental phytase (PHYZYME). At 6 wk, pullets from each treatment combination were placed in individual cages and fed 74 g EOD. Total excreta was collected for 48 h and this was repeated twice. Similar to what was observed for Experiment 1, there was a linear increase in excreta P with each increase in dietary concentration. Phytase supplementation decreased P in the excreta by 18% in the 0.15% AvP treatment and 6.5% in the 0.25% AvP treatment. There were no differences in excreta P due to phytase supplementation in the 0.35% AvP treatment. Pullets were fed the same levels of AvP with and without phytase during the breeder phase and during each of the first four 28 d production periods, hen-day egg production in hens fed 0.15% AvP with and without phytase was similar to that of the other diets.

**Key Words:** Broiler breeders, Phosphorus, Excretion

**23 Male-male competition for matings in broiler breeders.** I. Estevez<sup>\*</sup>, B. Bilcik, and M. R. Luque, University of Maryland, College Park.

In natural mating systems where male broiler breeder compete for access to females, male mating behavior will determine the number of successful copulations attained by each male and ultimately their fertility. We investigated the effect of male-male competition on mating behavior and compared it to a non-competitive situation. Twelve groups of three males and 12 females were housed in mixed sex pens (Phase 1). The frequency of matings, cloacal contacts and forced matings, and the identity of the male were extracted from videotapes collected by cameras installed above each pen. The reproductive success of each male during Phase 1 was determined through DNA fingerprinting. Males with the highest (H) and the lowest (L) mating frequency were later placed into groups of one male and four females (Phase 2), their behavior recorded and their fertility calculated. Our results indicate that both mating status (MS) and the MS by Phase interaction had an effect on the frequency of matings and

cloacal contacts ( $P < 0.001$ ). H males with higher frequency of matings and cloacal contacts in the competitive situation (Phase 1) reduced their frequency during Phase 2 (Tukey,  $P < 0.01$ ). In contrast, L males had a higher mating frequency and cloacal contacts in Phase 2 as compared with Phase 1 (Tukey,  $P < 0.05$ ). These changes resulted in no behavioral differences across H and L males in Phase 2 (Tukey,  $P > 0.05$ ). Despite of the differences in mating behavior during Phase 1 these did not result in differences in reproductive success of H and L males ( $P > 0.05$ ). This may in part be explained by the tendency ( $p = 0.06$ ) of a higher mating success (cloacal contacts / matings) for L males (71.09% and 58.03% for L and H males, respectively). The frequency of forced matings was low for both H and L males, even in the competitive situation, and was not affected by any of the factors ( $P > 0.05$ ). In conclusion, male competition had a significant effect on the mating behavior and frequency of cloacal contacts of broiler breeders, but not on their frequency of forced matings. However these differences did not result in differential reproductive success.

**Key Words:** Broiler breeders, Mating behavior, Reproductive success

**24 Effects of ad libitum feeding on sexual maturation, ovarian morphology, and carcass traits in 8 strains of broiler breeder hens.** M. E. Rustad<sup>\*1</sup>, F. E. Robinson<sup>1</sup>, R. A. Renema<sup>1</sup>, M. J. Zuidhof<sup>2</sup>, and B. Fancher<sup>3</sup>, <sup>1</sup>University of Alberta, Edmonton, AB, Canada, <sup>2</sup>Alberta Agriculture, Food and Rural Development, Edmonton, AB, Canada, <sup>3</sup>Aviagen, Huntsville, Alabama.

The negative correlation between reproductive traits and growth traits causes problems for broiler breeder producers. They are forced to use feed restriction to control the BW of current stocks to obtain acceptable fertility and egg production. However, this method is not consistently used effectively, and birds may get more nutrients than is recommended for that strain. The objective of this study was to determine the effect of over-feeding 8 genetic strains of broiler breeder hens on age at sexual maturity, ovarian morphology, and carcass traits.

Two replicate pens per strain were reared from 0 to 17 wks. The birds were weighed twice weekly and kept to a specific target BW via weekly feed allocations. At 17 wks, 64 birds per strain were selected based on BW and randomly allocated to one of two groups. One group was fed either ad libitum (FF) or were feed restricted (R) from 18 wk to sexual maturity (SM). The second group was fed ad libitum or feed restricted from 22 wk to SM. Birds were photostimulated at 22wks. At SM, BW, shank length, breast, liver, fatpad, ovary, oviduct, stroma, follicle weights were measured.

Strain 1 (selected for large BW) had the largest BW (4186 g), ovary (83.8 g), and number of large yellow follicles (LYF) (10.3) at SM. This strain is adept at depositing protein to increase growth and utilize lipids for follicular development. Strain 3 (pure line) had the highest percentage fatpad (3.1%), and the lowest number of LYF (8.2). This strain reacts differently than strain 1 to excess feed, as the extra nutrients are not converted to lipids for growth of more LYF, but are rather stored as carcass fat. The 18 FF treatment had the largest BW