237 Influence of cereal type, heat processing of the cereal, and inclusion of fiber in the diet on organ weights and ileal digestibility of nutrients in broilers. E. Jiménez–Moreno, J. M. González–Alvarado, A. de Coca, R. Lázaro, and G. G. Mateos*, *Universidad Politécnica de Madrid*, *Spain*.

The effects of diet composition on development of digestive organs and apparent ileal digestibility (AID) of nutrients were studied in 21 d old broilers. There were twelve treatments arranged factorially with two cereals (corn and rice), two processing methods (HP) (raw and cooked at 90°C from 50 min), and three fiber sources [none, 3% oat hulls (OH), and 3% soybean hulls (SH)]. Each treatment was replicated three times (a cage with 16 chicks). The control diets were based on cereal (60% of either corn or rice), soy protein concentrate, soy oil, and 1% celite, and the crude fiber content was 2.4% (corn diet) and 1.5% (rice diet). Relative weights (RW) of proventriculus (0.78 *vs.* 0.75% BW) and gizzard (3.28 *vs.* 2.84% BW) were higher for broilers fed corn than for broilers fed rice ($P < 0.001$). HP of corn reduced gizzard RW ($P < 0.05$) whereas HP of rice did not have any effect. Oat hulls increased gizzard RW (3.37 *vs.* 2.96% BW; $P < 0.001$) whereas SH increased proventriculus RW (0.78 *vs.* 0.74% BW; $P < 0.001$). An interaction cereal × hulls inclusion was detected; the increase in gizzard RW because of OH was higher for the rice– than for the corn– based diets ($P < 0.05$). Hulls inclusion increased gizzard digesta content, an effect that was more pronounced in the rice– than in the corn– based diets ($P < 0.001$). The AID of nutrients was higher for rice than for corn diets ($P < 0.001$). An interaction cereal × HP was observed; HP improved AID of DM and gross energy in the corn diets but had the opposite effects in the rice diets ($P < 0.01$). Hulls inclusion improved AID of DM and gross energy ($P < 0.05$) and the benefits observed were more pronounced with OH than with SH ($P < 0.1$). We concluded that the inclusion of an insoluble fiber source to low–fiber diets stimulates gizzard function and improves nutrient utilization. Therefore, it is recommended to include a minimal amount of insoluble fiber in diets for young broilers.

Key Words: fiber inclusion, ileal digestibility, broiler

Processing, Products, and Food Safety: Broiler Microbiology

238 Growth of *Campylobacter* spp. in media supplemented with organic acids. A. Hinton, Jr.*, *Russell Research Center*, *Athens, Georgia*.

Campylobacter spp. are the main cause of bacterial foodborne illnesses in humans, and contaminated poultry products are major sources of campylobacteriosis. In this study, the growth of *Campylobacter* spp. in media supplemented with organic acids was examined. Tryptose-yeast extract basal broth medium was supplemented with 0, 10, 20, 30, 40, or 50 mM of citric, fumaric, lactic, malic, or succinic acid then inoculated with cultures of *Campylobacter coli* ATCC 33559, *Campylobacter fetus* subsp. *fetus* ATCC 27349, or *Campylobacter jejuni* subsp. *jejuni* ATCC 33560. Inoculated media were transferred into a MACS VA500 Microaerophilic Workstation, and 0.1 ml of the bacterial suspensions were dispensed into wells of a Honeycomb 2 cuvette plate. Each cuvette well was overlaid with 0.1 ml of sterile mineral oil, and the filled Honeycomb 2 plates were transferred to the incubator tray of a Bioscreen C Microbiology Reader. The microbiology reader measured the absorbance of the suspensions after cultures were incubated at 37°C for 48 h. Results indicated that growth of *C. coli* ATCC 33559 and *C. jejuni* subsp. *jejuni* ATCC 33560 were significantly ($P < 0.05$) higher when cultured in media supplemented with 20 to 50 mM of either organic acid than when cultured in media not supplemented with an organic acid. Growth of *C. fetus* subsp. *fetus* ATCC 27349 was significantly ($P < 0.05$) greater in media supplemented with 10 to 50 mM of either organic acid, except for citric acid, than in non-supplemented media. Growth of the *Campylobacter* isolates was also measured in basal media supplemented with a mixture of 10, 20, 30, 40, or 50 mM of fumaric, malic, lactic, and succinic acids utilizing the same methods used to examine growth in media supplemented with individual organic acids. Results indicated that the growth of all isolates was significantly ($P < 0.05$) greater in media supplemented with mixtures containing 10 to 40 mM of each organic acid than in non-supplemented media. Findings of this study illustrate that growth of *Campylobacter* spp. may be enhanced when the bacteria are cultured in media supplemented with selected organic acids. These supplemented media may be useful in conducting research on intervention methods for reducing contamination of poultry products by this pathogen.

Key Words: *Campylobacter*, media, organic acids

239 Organic acid water treatment reduced *Salmonella* horizontal transmission in broiler chickens. C. Knight*[1], C. Hofacre[2], G. Mathis[3], M. Quiroz[1], and J. Dibner[1], [1]*Novus International, Inc*, *St. Louis, Missouri*, [2]*Poultry Diagnostic & Research Center*, *Athens, Georgia*, [3]*Southern Poultry Research, Inc.*, *Athens, Georgia*.

The purpose of the present study was to determine whether an organic acid water treatment could reduce the spread of *Salmonella* (SAL) to naïve birds when infected birds were part of the population. A total of one thousand eighty (1080), day-old Cobb X Cobb male chicks were allocated 60/pen to each of 18 pens by blocks and divided into three treatment groups: T1, unmedicated control; T2 , 0.04%; and T3, 0.08% of an organic acid blend (OAB; ACTIVATE® US MAX). The OAB was added to water from 0-14 days and 42-49 days. Half of the birds in each pen were orally dosed with Naladixic acid resistant-S. heidelberg on Day 0 (tagged) and housed with the remaining uninfected birds (not tagged). *Salmonella* status of ceca and crops (Day 49 only) was evaluated by random selection of 5 tagged and 5 untagged birds/pen on days 0, 14 and 49. Dragswabs of pens were also obtained on the same days as was mortality, weight gain, feed consumption and feed conversion. On day 49, 22% of T1 untagged birds had SAL+ ceca compared to only 7% of T2 and T3 untagged birds(P<.05). In addition, the %SAL+ crops of untagged birds and SAL+ dragswabs of the pens were significantly reduced for T2 and T3. There was no effect of OAB on % SAL+ ceca or crops for tagged birds. This finding is consistent with the hypothesis that the OAB have their primary anibacterial effects at low pH (upper gastrointestinal tract) and would tend to reduce survival and subsequent cecal colonization of SAL consumed by naïve birds but have no impact on SAL already present in the ceca. Feed conversion was improved (P<.05) by OAB at 42 days of age (1.80 vs 1.77 and 1.77) and at 49 days similar trends were apparent (1.95 vs 1.90 and 1.91) but not different, nor were there differences in

gain or mortality. These results demonstrated that the OAB treatment significantly reduced horizontal spread of SAL to uninfected birds and reduced environmental SAL contamination.

®ACTIVATE is a registered trademark of Novus International, Inc.

Key Words: organic acids, ACTIVATE, *Salmonella*

240 Control of caecal *Salmonella* by dietary FOS in probiotic treated broiler chickens. J. R. Chambers*[1], J. Gong[1], B. Sanei[2], C. Gyles[3], M. A. Hayes[3], and S. Sharif[3], [1]*Food Research Program, AAFC*, *Guelph, ON, Canada*, [2]*Ontario Ministry of Agriculture and Food*, *Guelph, ON, Canada*, [3]*OVC, University of Guelph*, *Guelph, ON, Canada*.

To test the potential of dietary fructooligosaccharides (FOS, 0.5% by wt) to reduce caecal *Salmonella* counts, broiler chicks were challenged with NalR *Salmonella*, either typhimurium or heidelberg, in two trials (set 1). In each trial, hatched chicks were gavaged with either no probiotics (control), a defined probiotic (8 or less known organisms) or a non-defined probiotic (numerous organisms not all known). Next day, caeca from 1 chick per treatment, 6 total, were sampled to be tested for *Salmonella* (none detected) before the remaining 132 chicks were gavaged with 104 cfu of *Salmonella* in 0.5 ml suspension. Chicks were provided a crumbled, broiler started ration and distilled H2O, half receiving FOS. They were confined in 6 small pens with litter floors and solid walls. This plan was repeated with two other probiotics in two trials (set 2). At 1, 2 and 4 weeks post-challenge, caecal contents of 7 chicks per treatment were cultured on BGS agar plates with nalidixic acid. Samples with no colonies had material previously preenriched in Selenite Cystine broth cultured to distinguish between low level positive and negative status. Salmonella counts were analysed using Proc GLM of SAS with probiotic, prebiotic, age and trial (serotype) and interactions in the model. Sets were analysed separately becaused probiotics differed. FOS had no significant influence on Salmonella; however, interactions with probiotics and age in set 1 were significant ($P \leq 0.01$). Small reductions (0.7 logs) of *Salmonella* existed if FOS fed broilers were treated with the non-defined probiotic. Corresponding values in set 2 were non-significant ($P \geq 0.05$). In set 1 the FOS effect was predominant at 1 wk post-challenge leading to a significant interaction ($P \leq 0.01$) between prebiotic and age. Results suggest FOS reduces caecal Salmonella by small amounts. Moreover, it may need to be used with specific probiotics to realize benefits.

Key Words: FOS, *Salmonella*, probiotic

241 Effect of internal versus external fecal contamination on broiler carcass microbiology. D. P. Smith*, J. K. Northcutt, J. A. Cason, A. Hinton, Jr., R. J. Buhr, and K. D. Ingram, *USDA, ARS, Russell Research Center*, *Athens, Georgia*.

A study was conducted to determine the effect of visible external or internal fecal contamination on the microbiology of broiler carcasses. In each of three trials, 12 uneviscerated carcasses were obtained from a commercial processing plant, placed on a shackle line and eviscerated on commercial equipment in a pilot plant. One g of cecal contents was placed on either the exterior breast area to mimic outside contamination (OC), inside the carcass (IC), or not applied (Control). All carcasses were held 10 min prior to washing. Carcasses were replaced on the shackle line and passed through a commercial inside-outside bird washer (IOBW) set at 80 PSI (552 kPa), 5 s dwell time, using approximately 47 gal (178 L) per min of tap water at ambient temperature. Whole carcass rinses (WCR) were conducted and coliforms, *E. coli*, and *Campylobacter* counts were determined and are reported as log cfu/ml rinse. Coliform counts for OC (5.0) were significantly ($P<0.05$) greater than IC (4.5), which were significantly greater than Control (3.7). *E. coli* counts from OC (4.9) were significantly greater than IC (4.2), which were greater than Control (3.6). *Campylobacter* counts for OC (3.6) were significantly greater than IC (2.6), which were greater than Control (2.2). Visible contamination was observed on post-wash OC carcasses, but not in or on post-wash IC carcasses. In this study, post-wash carcasses with internal contamination had fewer bacteria than carcasses with external contamination. However, washing did not reduce bacteria from internally contaminated carcasses to control levels.

Key Words: fecal contamination, inside-outside bird washer, *Campylobacter*

242 Inhibition of *Campylobacter* and *Salmonella* on whole chicken carcasses using a novel intervention technology. T. W. Thompson*, C. Z. Alvarado, and M. M. Brashears, *Texas Tech University*, *Lubbock*.

A study was conducted to determine the effectiveness of Protectatm pc intervention on the reduction of *Campylobacter* and *Salmonella* on poultry carcasses. Protectatm pc intervention was compared to ambient water (CONTROL), and no rinsing (UNTREATED CONTROL). A total of 90 carcasses where used to evaluate the reduction of either *Campylobacter* or *Salmonella*. Each group had 3 replications with 5 carcasses being used in each of the 3 treatments. In the pathogen processing lab at Texas Tech University, a cocktail mixture of 4 strains of *Campylobacter* spp. and *Salmonella* spp. were prepared and added to chicken carcasses by dipping to yield a population of approximately 7.5 log10 cfu/g of rinsate from the carcasses. Bacteria were allowed to attach for 30 min prior to application of interventions or sampling. The USDA poultry rinse method was used to sample the chickens. Standard FDA-BAM methods were used to enumerate *Campylobacter* spp. on the carcasses. The CONTROL and UNTREATED CONTROL samples contained 7.23 and 7.46 log10 cfu/ml of *Campylobacter* spp. after treatments, and the CONTROL and UNTREATED CONTROL samples contained 3.19 and 7.49 log10 cfu/ml of *Salmonella* spp. after treatments. The Protectatm pc treated carcasses yielded 6.32 and 7.02 log10 cfu/ml of *Salmonella* spp. and *Campylobacter* spp. respectively. The Protectatm pc treatments had a 1.7 log10 cfu/ml reduction for *Salmonella* and a 0.45 log10 cfu/ml reduction for *Campylobacter*; when compared to the UNTREATED CONTROL. Treatments with ambient water did not result in a significant reduction of *Campylobacter* spp. or *Salmonella* spp. on the carcasses. While there were still pathogens remaining after all treatments, the reductions with Protectatm pc can help reduce to total number of bacteria on broiler carcasses.

Key Words: *Campylobacter*, *Salmonella*, poultry

243 Recovery of bacteria from broiler carcasses after immersion chilling in different volumes of water, Part 2. J. K. Northcutt*[1], J. A. Cason[1], K. D. Ingram[1], D. P. Smith[1], R. J. Buhr[1], and A. Hinton, Jr.[1], [1]*USDA-ARS*, *Athens, Georgia*, [2]*The University of Georgia*, *Athens*.

In a previous study, the levels of bacteria recovered from broiler carcass halves after immersion chilling in a low volume of water (2.1 L/kg) were greater than the levels of bacteria recovered from halves after immersion chilling in a high volume of water (16.8 L/kg). A second study was conducted to determine if the recovery of bacteria from chilled broiler carcass halves would be different if a commercial immersion chilling volume was used (3.3 L/kg) compared to double that volume (6.7 L/kg). For this study, pre-chill broiler carcasses were removed from a commercial processing line, cut into left and right halves, and one half of each pair was individually chilled in a bag containing either 3.3 L/kg or 6.7 L/kg distilled water. Bags containing halves were submersed in a secondary chill tank containing approximately 150 L of an air-agitated ice-water mix (0.6°C). After 45 min, halves were removed, allowed to drip for 5 min, and rinsed with 100 mL of sterile water for 1 min. Rinses were analyzed for total aerobic bacteria (APC), *Escherichia coli* (EC), *Enterobacteriaceae* (EN) and *Campylobacter* (CP). When the numbers of bacteria in the half-carcass rinses (HCR) were compared, counts recovered from halves chilled in 3.3 L/kg of water were the same as those recovered from the halves chilled with 6.7 L/kg of water ($P > 0.05$). Levels found in the HCR ranged from 4.0 to 4.2 $\log_{10}$cfu/mL for APC, 3.3 to 3.5 $\log_{10}$cfu/mL for EC, 3.6 to 3.8 log10 cfu/mL for EN and 2.4 to 2.6 $\log_{10}$cfu/mL for CP. Data were also analyzed using a paired comparison t-test, and this analysis also showed that there was no difference ($P > 0.05$) in the numbers of APC, EC, EN or CP recovered from paired-halves chilled in different volumes of water. The present study shows that doubling the amount of water that is traditionally used during immersion chilling (6.7 L/kg) will not improve the removal of bacteria from the surfaces of chilled carcasses.

Key Words: poultry, immersion chilling, chiller water

244 Coliforms, *E. coli*, *Campylobacter*, and *Salmonellae* in a counterflow broiler scalder with a dip tank. J. A. Cason* and A. Hinton, Jr., *Russell Research Center*, *Athens, Georgia*.

Suspended bacteria were enumerated in scald water and carcass rinse samples from a commercial broiler processing plant with a multiple-tank, counterflow scalder. After five-week old broilers had been processed for eight hours, water samples were taken on six days from each of three scald tanks and from a dip tank located between defeathering machines. Coliforms, *E. coli*, and *Campylobacter* were enumerated and the Most Probable Number (MPN) of *Salmonellae* was determined in water samples and in rinses of carcasses removed from the processing line immediately after defeathering. Mean coliform concentrations in Tanks 1, 2, and 3 were 4.6, 2.5, and 1.6 log10(cfu/ml), respectively. *E. coli* concentrations followed the same pattern with means of 4.4, 2.1, and 1.4 in Tanks 1, 2, and 3, respectively, with significant differences (P<.05) in the concentrations of both coliforms and E. coli between the tanks. Mean *Campylobacter* concentration in four positive samples from Tank 1 was 4.0 log10(cfu/ml), but only one water sample from Tank 2 and none from Tank 3 were *Campylobacter* positive. Coliforms and *E. coli* were found in dip tank samples in only two instances, with no isolations of *Campylobacter* or *Salmonellae*. Mean numbers of coliforms, *E. coli*, and *Campylobacter* in carcass rinses were 3.1, 2.7, and 3.3 log10(cfu/ml). *Salmonellae* were isolated from five of six water samples from Tank 1 with a mean MPN of 13.3/100mL, but were isolated from only three of six water samples from Tank 2 and two of six from Tank 3. *Salmonellae* were isolated from half (18/36) of all carcass rinses. Most bacteria suspended in scald water were found in the first tank, with no *Campylobacter* or *Salmonellae* found in the dip tank. Counterflow, multiple-tank scalders appear to reduce the opportunity for cross-contamination during scalding.

Key Words: scalding, bacteria, *Salmonella*

245 Colonization of the reproductive tract and deposition inside eggs laid by hens infected with *Salmonella enteritidis* or *S. heidelberg*. R. K. Gast*, R. Guraya, J. Guard-Bouldin, P. S. Holt, and R. W. Moore, *USDA-ARS, Egg Safety and Quality Research Unit*, *Athens, Georgia*.

Internal contamination of eggs by *Salmonella enteritidis* has been a significant source of human illness for several decades and is the focus of a recently proposed FDA regulatory plan. *Salmonella heidelberg* has also been identified as an egg-transmitted human pathogen. The deposition of *Salmonella* strains inside eggs is a consequence of reproductive tissue colonization in infected laying hens, but the relationship between colonization of specific regions of the reproductive tract and deposition in different locations within eggs is not well documented. In the present study, groups of laying hens were experimentally infected with large oral doses of *S. heidelberg*, *S. enteritidis* phage type 13a, or *S. enteritidis* phage type 14b. For all of these strains, the overall frequency of ovarian colonization (34%) was significantly higher than the frequency of isolation from either the upper (23%) or lower (18%) regions of the oviduct. No significant differences were observed in the frequency of *Salmonella* isolation from egg yolk or albumen (4.0% and 3.3%, respectively). Some significant differences between strains were observed in the frequency of isolation from eggs, but not in the frequency or patterns of isolation from reproductive organs. Accordingly, although the ability of these *Salmonella* strains to colonize different regions of the reproductive tract in laying hens was reflected in deposition in both yolk and albumen, there was no indication that any specific affinity of individual strains for particular regions of this tract produced distinctive patterns of deposition in eggs.

Key Words: *Salmonella*, reproductive tract, eggs

246 Prevalence of *Salmonella*, *Campylobacter* and *Listeria* on the surface of vacuum loaders in shell egg processing plants. D. R. Jones* and M. T. Musgrove, *USDA-ARS, Egg Safety and Quality Research Unit*, *Athens, Georgia*.

Previous studies have examined the effectiveness of sanitation programs in shell egg processing facilities. The results showed vacuum loaders to be a reservoir of high levels of aerobic bacteria and Enterobacteriaceae. This study was conducted to determine the prevalence of *Salmonella*, *Campylobacter* and *Listeria* on the surface of the suction cups from the vacuum loaders. Two shell egg processing facilities were sampled (one offline, one mixed operation) on three occasions each (weekly). One third of the suction cups (20 per visit) were randomly selected for sampling each visit with the aid of a random number table. Cups were removed from the vacuum loader and placed in a sterile sample bag

with 50 mL of sterile phosphate buffered saline. Cups were rinsed for one minute before being returned to the vacuum loader. Rinsates were transported on ice to the laboratory for analysis. Total aerobic populations and Enterobacteriaceae were enumerated. Appropriate methodology was utilized to determine the prevalence of *Salmonella*, *Campylobacter* and *Listeria*. Aerobic population and Enterobacteriaceae levels were similar to those determined in the previous sanitation studies (5.5 and 2.3 log cfu/mL, respectively). There was no *Campylobacter* found on the vacuum loaders. Less than 10% of the samples were positive for *Salmonella*. There was a very high incidence of *Listeria* found on the suction cup surfaces. Biochemical tests confirmed presumptive isolates to be *L. innocua* and *L. monocytogenes*. These results indicate that additional research is needed to improve the cleaning and sanitation procedures for suction cups on vacuum loaders to reduce the incidence of these pathogens in the shell egg processing environment.

Key Words: egg processing, vacuum loaders, pathogens

247 *Enterobacteriaceae* and related organisms isolated from shell eggs washed in cooler wash water. M. T. Musgrove* and D. R. Jones, *Egg Safety and Quality Research Unit, USDA-ARS*, *Athens, Georgia*.

Processing guidelines in 7 CFR part 56 dictate that shell eggs be washed in water at 32- 49 C. As they pass through dual commercial washers, egg temperatures often rise to levels conducive to bacterial growth. A commercial study was conducted to determine if washing eggs with cooler water would allow for reduced temperatures but preserve microbiological quality. An in-line and off-line facility were each sampled on 3 times. Wash water treatments were: HH = 49C, 49C; HC = 49C, 24 C; and CC = 24 C, 24 C. On each visit, 4 3-egg pools per treatment were sampled by crushing shells and membranes with 30 mL of phosphate buffered saline. *Enterobacteriaceae* were detected by pour-plating shell/membrane homogenates with violet red bile glucose agar and incubated at 37 C for 24 h. Five isolates per positive sample were randomly selected, streaked three times to ensure purity, and identified to genus level using biochemical testing. Shell surface temperatures for the 3 treatments (HH, HC, CC) averaged 26.2, 22.7, 21.2 C for in-line eggs and 20.2, 18.6, and 17.2 C for off-line eggs. Identifications were made for 257 in-line and 45 off-line isolates. *Escherichia* and *Enterobacter* were the most frequently identified genera from either facility, regardless of treatment. *Citrobacter*, *Klebsiella*, *Leclercia*, *Proteus*, *Salmonella*, and *Serratia* were also recovered from both facilities. Other *Enterobacteriaceae* recovered from the in-line facility included *Buttiauxella*, *Erwinia*, *Hafnia*, *Kluyvera*, *Morganella*, *Providencia*, and *Yersinia*. Only *Enterobacteriaceae* were identified from off-line eggs though related species were recovered from the in-line eggs(*Aeromonaceae* and *Pseudomonas cepacia*). Differences in *Aeromonaceae* (*Aeromonas*, *Listonella*, *Vibrio*) prevalence were observed by treatment: 31.8, 25.7, and 47.1% for HH, HC, and CC, respectively. Higher proportions of *Salmonella* were presumptively identified from HC (36.5%) and CC (20.0%) than from HH washed eggs (5.0%). The 3-5 C reduction in shell surface temperature resulting from using cooler wash water temperatures may not be worth the observed decrease in microbiological quality.

Key Words: shell eggs, processing, *Enterobacteriaceae*

248 Microbiological survey of seven types retail shell eggs. M. T. Musgrove* and D. R. Jones, *Egg Safety and Quality Research Unit, USDA-ARS*, *Athens, Georgia*.

A variety of shell eggs are available at retail, marketed to accommodate consumer preferences for esthetic, nutritional, or microbiological/safety perceptions and needs. In light of imminent changes to egg washing and packing regulations, any microbiological information on retail eggs processed under current guidelines will be useful for future comparison. A microbiological survey was conducted of eggs purchased in Athens, GA grocery and health food stores. Seven types of grade A large eggs were included in the study: (1) traditionally processed; (2) nutritionally enhanced; (3) in-shell pasteurized; (4) vegetarian fed; (5) free-range/fertile; (6) cage free; and (7) kosher. Eggs were transported back to the laboratory in cartons and ten of each type were aseptically sampled by a shell/membrane crush method. Egg contents were also collected. Aerobic plate, Yeast/mold, and *Enterobacteriaceae* counts were determined for individual egg shells/membranes and content samples by plating on plate count, dichloran rose bengal chloramphenicol, and violet red bile glucose agar, respectively, using appropriate incubation times and temperatures. For each egg type, three 3-egg pools of shell/membrane homogenates and three 3-egg content pools were enriched for the detection of *Salmonella*, *Campylobacter*, and *Listeria*. Accepted methods of pre-enrichment, enrichment, selective plating, and confirmation were employed for each pathogen population. All microbial counts are reported as log cfu/mL for egg types 1-7. Aerobic egg shell/membrane counts by egg type were 1.2, 2.6, 1.5, 0.6, 1.4, 1.4, and 2.2, respectively. Yeast/mold counts were 0.1, 0.1, 0.3, 0.1, 0.2, 0.0, and 0.0, respectively, while *Enterobacteriaceae* counts were determined to be 0.3, 0.1, 0.3, 0.0, 0.2, 0.1, and 0.0, respectively. None of these populations was detected in any of the egg content samples. *Salmonella*, *Campylobacter*, and *Listeria* were absent from shell/membrane homogenate and content pools for all egg types sampled. These results indicate that shell eggs available in the retail market have acceptable microbiological quality and safety characteristics.

Key Words: shell eggs, microbiology, retail

249 Albumen quality and functionality from eggs produced by hens from five layer strains over two production cycles. P. A. Curtis*[1], L. K. Kerth[1], and K. E. Anderson[2], [1]*Auburn University*, *Auburn, Alabama*, [2]*North Carolina State University*, *Raleigh*.

Egg processors who break eggs to create a variety of egg products, want large eggs that consistently produce high quality egg products. Consistency is the major problem with eggs, particularly in the albumen products. It is well known that as the hen ages a number of changes occur in the egg. Bird age has been reported to have an impact on egg size and composition. Egg weights generally increase as the bird ages. Egg weights are also influenced by strain. In order to study such problems, strains of layer hens bred for the egg breaking industry were evaluated looking at the quality and functional characteristics of eggs over a complete two year cycle which included a molt. Eggs from five strains of birds from the 35th North Carolina Layer Management Test were analyzed over a 24 period laying cycle for albumen quality. The strains utilized were the Hy-Line W-36, Hy-Line W-98, Hy-Line CV-20, ISA White, and Bovans White. These strains were selected based upon their egg weight, availability, and market share. Strain preformance was monitored under identical rearing and environmental

conditions throughout the test. The hens were provided nutrients to meet the needs of all the hens based upon compilation of the breeder recommendations. The eggs from these strains were collected every 28 days from the previous 24 hrs production. Once collected the quality and compositional properties of the eggs such as pH, solids, whipping height, Haugh units and angel food cakes were evaluated. Angel food cake volumes had greater variation in the first laying cycle (first 12 months) than in the second laying cycle (second 12 month period). None of the other quality measurements analyzed were a good predictor of cake volume. Egg weights were also influenced by strain. The strains with the highest ($P<0.05$) egg weights were the W-98, and ISA White at 61.2 and 61.0 g, respectively. The lowest egg weights were associated with the W-36 hen's eggs weighing 57.1 g during the first cycle.

Key Words: egg quality, albumen functionality

250 Functionality and quality of whole eggs and yolk from five different layer strains over two production cycles. L. K. Kerth*[1], P. A. Curtis[1], and K. E. Anderson[2], [1]*Auburn University*, *Auburn, Alabama*, [2]*North Carolina State University*, *Raleigh*.

Breeders in the modern commercial environment have been developing and selecting layer strains for the production of large egg sizes to enhance yield. However, the impact of such breeding programs on egg composition has not been evaluated. To date the research that has been conducted only looks at a few characteristics and does not look at those characteristics over a complete laying cycle or as the hen ages. Therefore, in this study five commercial layer strains were selected based upon their egg weight, availability, and market share and were monitored for a complete two year laying cycle (17-114 weeks of age) including a molt. The five strains that were utilized in this study are Hy-Line W-36, Hy-Line W-98, Hy-Line CV-20, Bovans White and ISA White. Eggs were collected every 28 days from the 35th North Carolina Layer Performance and Management Test in which the strains were maintained under identical husbandry and environmental conditions throughout the study. After collection, the quality, functional, and compositional properties of the eggs were determined. During the first production cycle (17-66 weeks of age) the functionality of the whole egg as tested by sponge cake volume was very erratic ($P<0.05$) between the strains. However, the volume of the sponge cakes became much more consistent among the strains ($P>0.05$) during the second cycle (70-114 weeks of age). Egg weights and whole egg solids were also significantly ($P<0.05$) influenced during both cycles by strain. Emulsion strength of mayonnaise was impacted by hen age and strain during both production cycles. Yolk solids had no difference ($P>0.05$) among the five strains during the first cycle, but there was a significant difference ($P<0.05$) during the second. Vitelline membrane strength was also impacted over the complete laying cycle by hen age and strain ($P<0.05$). Both hen age and strain appeared to influence the functional properties of the eggs produced.

Key Words: egg quality, yolk functionality, whole egg functionality

Physiology, Endocrinology, and Reproduction: Reproduction

251 Are thermal manipulations to improve thermotolerance during chick's embryogenesis only a question of fine tuning? S. Yahav*, *Institute of Animal Science ARO the Volcani Center*, *Bet Dagan, Israel*.

Thermal manipulations during chick's embryogenesis are based on the following hypothesis: a. during embryogenesis, inducing long lasting physiological memory, based on epigenetic adaptation, is achievable; b. the meaning of long lasting memory can be defined, most probably, as alteration in the thermoregulatory hypothalamic threshold response to changes in the environment; c. thermal manipulations during the sensitive periods of embryogenesis, using specific level and duration of heat exposure will achieve the improvement of thermotolerance acquisition during life span. It was previously well documented that thermal manipulations during the 1st week post-hatch reach the targeted aim of improved thermotolerance. However, technical problems to adopt these manipulations in chicks, coupled with the hypothesis that during embryogenesis thermal manipulations maybe more efficient for the improvement of thermotolerance, targeted the chick embryogenesis as a promising period for manipulations. Thermal manipulations during 8 to 10, and 16 to 18 d of embryogenesis were conducted using 6 h exposure to 39.5C on each day. These treatments didn't affect hatchability or development upon hatch or later on. Challenging the treated chicks with hot conditions for 3 d demonstrated a better thermotolerance (significantly lower body temperature coupled with lower thyroid hormones concentration) and stress resistance of the manipulated embryos at 16 to 18 d of embryogenesis. However, challenging the chickens at marketing day (42 d of age) did not show any thermotolerance efficiency/advantage of the manipulated chickens. Moreover, these chickens lost their relatively lower body temperature with age, meaning, they lost their efficiency to better cope with heat challenge. These results raise the following questions: a. is it possible that there is no way to induce long lasting thermoregulatory memory by thermal manipulations during embryogenesis? or b. is it only a question of thermal manipulation fine tuning? Further research is needed to shed light on this topic, although there are evidences that fine tuning may achieve the targeted goal.

Key Words: embryogenesis, thermotolerance, thermal manipulations

252 Incubator temperature and oxygen concentration affect the physiology of selected muscles of broiler embryos at the plateau stage in oxygen consumption. V. L. Christensen*, D. T. Ort, M. M. Mann, M. J. Wineland, P. E. Mozdziak, S. L. Funderburk, J. L. Grimes, and E. R. Oviedo, *North Carolina State University*, *Raleigh*.

An apparent paradox in energy budgets of avian eggs and metabolism occurs at the plateau stage in incubation as heat output increases, but oxygen utilization does not. When confronted with life-threatening situations, embryonic organ growth and function may be antagonistic. Temperature manipulations have been shown to affect the posthatch phenotype through muscle alteration. Little is known of the effect of oxygen on embryonic muscle physiology. The objective of the current study was to test the effect of incubation temperature and fractional oxygen concentration at the plateau stage in development on muscle physiology. Eggs from two strains of broilers (high and low eggshell conductance (G) strains) were incubated normally for 18 d. At that