310 Photoperiod effects on spontaneous ovarian adenocarcinoma in the domestic turkey breeder hen. C. B. Moore and T. D. Siopes*, *Department of Poultry Science, College of Agriculture & Life Sciences, North Carolina State University, Raleigh*.

The effect of photoperiod or melatonin treatments on ovarian adenocarcinoma in turkey breeder hens was investigated. In Experiment 1, photoperiod effects were tested by exposing turkeys with ovarian tumors to 8 wks of short days (8:16LD) followed by a 12 wk period of long days (16:8LD). In Experiment 2, exogenous melatonin was administered to turkeys during long day-induced development of ovarian tumors. In both experiments, the stage of tumor growth was scored weekly on a subjective scale of 0 to 4. It was clear that exposure to short days produced complete regression of tumors, with a mean time to score 0 of 4.4 wks. Following re-exposure to a long photoperiod, all of the same birds showed re-growth of the ovarian tumor with a mean time to first palpable detection of 5.4 wks. When melatonin was administered daily during the long photoperiod (Experiment 2), there was a significant delay in the re-growth of tumors. It was concluded that the growth of solid ovarian tumors in the turkey breeder hen was promoted by long photoperiods and ceased, to the point of remission, on short photoperiods. Thus, ovarian adenocarcinoma in turkeys can be completely manipulated by photoperiod. In addition, treatment with melatonin attenuates tumor growth in the turkey hen. The results suggest that the domestic turkey hen may be a useful *in vivo* model for studying spontaneous ovarian adenocarcinoma.

Key Words: Cancer, Photoperiod, Ovary

311 The distribution and change in the number of gonadotropin-releasing hormone neurons in chicks following an increase in photoperiod plus administration of sulfamethazine. W. J. Kuenzel* and C. D. Golden, *University of Arkansas, Fayetteville*.

Gonadotropin-releasing hormone-1 (GnRH-1) neurons are well known to be critical for the regulation of gonadal development due to their stimulation of luteinizing hormone and follicle stimulating hormone release from the adenohypophysis. One consistent finding for GnRH-1 neurons is that their cell number remains relatively stable over the life cycle of a particular avian species. In addition, many studies have suggested that the principle location of GnRH neurons occurs in the medial preoptic hypothalamic region. A study was designed to determine whether significant increases in GnRH-1 neurons could be induced after treatment with a compound, sulfamethazine (SMZ), known to stimulate early sexual maturation. A two-by-two factorial [two diets (SMZ and control) and two photoperiods (shortday, LD8:16 and longday, LD16:8)] experiment was designed to determine whether photoperiod and/or SMZ could alter the number of GnRH neurons in male chicks. A set of sections extending from the septopallio-mesencephalic tract (TSM) to the end of the septal region was completed for each bird (n=5/treatment). Results showed that regarding the distribution of GnRH neurons, a low percentage were actually found to occupy the preoptic, hypothalamic region. In contrast, the vast majority of the neurons (75%) occurred in the subpallial brain region while the remainder was partitioned among three subgroups found in the diencephalon. No significant changes were noted in total GnRH-1 neurons among the four treatment groups, however, in one of the largest sub-groupings of GnRH neurons, the bed nucleus of the pallial commissure (NCPa), a significantly larger number of neurons were found in long-day SMZ fed birds compared to chicks raised in a short photoperiod (LD8:16) and fed a standard ration. Results suggest the importance of the NCPa, located in the subpallial region, as containing GnRH neurons that appear most responsive to manipulations of photoperiod in birds. Supported in part by NSF Grant # IBN-0315793 to W.J.K.

Key Words: GnRH, Subpallium, Reproduction

312 Changes in eggshell of Japanese quail during embryogenesis. S. Westmoreland*[1], P. Hester[2], and T. Halupnik[1], [1] *The University of Texas at Arlington, Arlington,* [2] *Department of Animal Science, Purdue University, West Lafayette, IN*.

The avian eggshell is a source of calcium for the developing embryo. Movement of calcium from the shell to the embryo occurs once the chorioallantois is in place and functional. At the blunt end of the egg the chorioallantois has no contact with the shell due to the airspace and no calcium loss occurs. The purpose of the current study was to investigate changes that occur in shells of fertile Japanese quail eggs during incubation in order to have a baseline study for comparison to eggs that were incubated at the MIR space station. It was hypothesized that when eggs reached the stage at which the chorioallantois was in place, shell samples from the equator region (largest shell diameter) would show signs of calcium loss and reduced shell thickness, while samples from the airspace would not. Fertile Japanese quail eggs were collected from a breeding colony at Purdue University. Incubation of the eggs was interrupted at six different intervals: 3, 7, 10, 12, 14, and 16 days. Eggshells were shipped to The Center for Electron Microscopy at The University of Texas at Arlington for analysis. Shells of three eggs for each incubation date were sampled in two regions, the airspace and equator. From each region five radial samples and one inner shell surface sample were prepared for viewing on the scanning electron microscope. Digital micrographs were taken to document shell changes. Measurements were collected of shell thickness for each radial sample. No changes were observed in shell samples from either airspace or equator in eggs incubated 12 days or less. In eggs incubated 14 or 16 days voids were seen in the mammillary cones of equator samples; no voids were found in airspace samples. For any given day of incubation, the equator region shell samples were consistently and significantly thicker than airspace samples. In eggs that had been incubated 14 and 16 days, the equator samples approached the thickness of the airspace samples. This trend is interpreted to indicate that shells are normally thicker at the equator than the airspace region, but the relative shell thickness changes at day 14 of incubation when the equator region becomes thinner due to calcium loss.

Key Words: Japanese Quail, Eggshell, Embryogenesis

PSA-Processing & Products: Microbiology & Egg Quality

313 Bacterial load of the crop of turkeys offered a feed supplement during preslaughter feed withdrawal. B. M. Rathgeber*[1], M. E. MacKenzie[1], and J. L. MacIsaac[2], [1] *Nova Scotia Agricultural College, Nova Scotia, Canada,* [2] *Atlantic Poultry Research Institute*.

Normally, feed is withdrawn from broiler turkeys several hours prior to the initiation of catching and shipping, allowing contents of the gut to pass through. This reduces the chance of bacterial contamination due to gut breakage during the evisceration process. During the starvation period there is an increased incidence of litter consumption increasing the bacterial load of the upper digestive tract. The objective of this study was to evaluate the use of a highly digestible supplement during preslaughter feed withdrawal as a means to reduce litter consumption and the bacterial load in the crop of turkeys. For each of two trials 480 female turkeys were grown in 8 pens (60/pen) at a density of 0.18m2 / bird. At 9 weeks of age 80 birds from half of the pens were shipped for processing (20 birds/pen). At 10 weeks of age 40 birds from the other four pens were shipped (10 birds/pen). Commercial feed was withdrawn 6 h prior to catching from each pen. A highly digestible nutritive supplement was offered in half of the pens for 5 h in duration. Water only was provided for the last hour before shipping. All birds were slaughtered 9 h after conventional feed was withdrawn. At 9 weeks, after feather removal the crops of 5 birds/pen were removed, placed in sterile bags and placed on ice. At 10 weeks 3 crops per pen were sampled. The number of aerobic bacteria as well as E. Coli, coliformes and salmonella were determined for each crop sampled. There was no difference between the numbers of bacteria in these groups for crops at 9 weeks old compared to 10 weeks. Salmonella was not found in any of the crops in these trials. The total number of aerobic bacteria in the crop was not influenced by the use of the nutritive supplement. Both E. coli and total coliformes were reduced in crops from birds offered the nutritive supplement prior to slaughter ($p<0.01$). This reduction was more than one log for each of these two categories. The results of this project indicate that populations of bacteria in crop of commercial turkeys can be re-

duced through administration of a highly digestible supplement during the normal preslaughter feed withdrawal period.

Key Words: Feed Withdrawal, Bacteria, Crop

314 Effect of a commercial inside-outside bird washer (IOBW) on *Campylobacter*, *Salmonella*, *E. coli*, and aerobic plate counts (APC) of uncontaminated, contaminated, and cross-contaminated broiler carcasses. D. P. Smith*, J. K. Northcutt, and M. T. Musgrove, *USDA, ARS, Russell Research Center, Athens, GA*.

Processors are washing carcasses with one or more in-line inside-outside bird washers (IOBW) due to zero fecal tolerance regulations. This study was conducted to determine the effect of an IOBW on *Campylobacter*, *Salmonella*, *E. coli*, and aerobic plate counts (APC) of uncontaminated (control), contaminated, and cross-contaminated broiler carcasses at two different IOBW water pressure settings. Three trials of 12 commercially processed carcasses each (two replications of six birds) were conducted as follows: two control carcasses, two carcasses contaminated with cecal contents (inoculated with *Campylobacter* and *Salmonella*) and allowed to dry on carcass skin for 12 min, and two carcasses uncontaminated and placed adjacent to contaminated birds during washing (to determine cross contamination) were prepared (n=36). Whole carcass rinses were conducted on each carcass prior to contamination or washing, then repeated after washing. Carcasses were washed with an in-line commercial IOBW set at 160 bpm (5 s) and either 40 or 80 PSI water pressure. There were no significant effects ($P<0.05$) from contamination with feces or from cross contamination, nor from IOBW pressure on any microbiological counts. The overall effect of washing was a slight (but not biologically) significant reduction in *E. coli* (3.2 to 3.0) and APC (4.9 to 4.8) $\log_{10}$cfu/ml rinsate. The IOBW decreased the incidence of *Campylobacter* from 14/36 positive carcasses to 1/36 positives, but *Salmonella* incidence for contaminated carcasses increased from 0/12 to 3/12 after washing. The IOBW removed carcass contamination to levels equivalent with control levels without cross contaminating other carcasses. The incidence of *Campylobacter* was decreased, though *Salmonella* was not reduced.

Key Words: Inside-Outside Bird Washer, Fecal Contamination, Broiler Carcass

315 Effects of spray washing with various chlorine levels and water temperatures on skin color and microbiology of broiler carcasses. J. K. Northcutt*, D. P. Smith, M. T. Musgrove, K. D. Ingram, and A. Hinton, Jr., *USDA, Agricultural Research Service, Russell Research Center, Athens, GA*.

A study was conducted to investigate the effects of chlorinated (sodium hypochlorite) spray washing using various water temperatures on breast skin color and microbiology of broiler carcasses. The experiment was a 2 x 3 randomized block design using 0 or 50 ppm added chlorine in tap water at a temperature of 21, 43 or 54°C. Breast skin color was measured and carcasses were subjected to a whole carcass rinse (WCR) before washing (Pre-treatment). Broiler cecal contents (4.95 g) were inoculated with a co-suspension (0.1 mL) containing 10^7 cells of *Campylobacter* and nalidixic acid resistant *Salmonella*, and 0.1 g were applied to each carcass. Inoculated carcasses were held at room temperature for 12 min before washing in a cabinet washer (80 psi for 5 sec). Immediately after washing, carcasses were subjected to a WCR, and breast skin color was measured again (Post-treatment). Tap water pH ranged from 7.2 to 7.6, and contained an average of 0.5 ppm free chlorine. After the addition of 50 ppm chlorine, water pH increased to 8.2 to 8.4. Washing temperature and additional chlorine had no effect on the breast skin color, with average values of L* = 66.6; a* = -0.09; b* = -0.05. Moreover, washing temperature and additional chlorine had no effect on total aerobic bacteria, *E. coli*, and *Campylobacter* levels on carcasses. Pre- and Post-treatment counts were found to be 4.6, 3.6, and 3.5 $\log_{10}$ cfu/mL rinse for total aerobic bacteria, *E. coli*, and *Campylobacter*, respectively. No nalidixic acid resistant *Salmonella* were found on Pre-treatment carcasses, and average Post-treatment levels were 3.1 $\log_{10}$ cfu/mL rinse irrespective of treatment. Under the conditions outlined in the present study, chlorine level and water temperature had no effect on skin color or broiler carcass microbiology.

Key Words: Inside-Outside Bird Washer, Chlorine, Carcass Contamination

316 Enrichment pH impact on salmonellae recovery from TSP-treated broiler carcasses. D. V. Bourassa*[1,2], R. J. Buhr[2], D. L. Fletcher[1], M. E. Berrang[2], and J. A. Cason[2], [1]*University of Georgia, Athens,* [2]*USDA-ARS Russell Research Center, Athens, GA*.

Trisodium phosphate (TSP) has been reported to reduce the recovery of salmonellae from processed poultry carcasses. It has been suggested that the high pH of TSP solutions as well as the detergent-like properties are responsible for the reduction in salmonellae recovery. This project was conducted to determine the efficacy of TSP and modified enrichment pH on the recovery of salmonellae. Carcasses were obtained from a commercial processing plant immediately after the final inside-outside carcass washer prior to chilling. Carcasses were subjected to one of four treatment groups; 1) TSP and neutral-peptone (pH 7.0), 2) TSP and acidified-peptone (pH 5.5), 3) no TSP and alkali-peptone (pH 8.5), 4) no TSP and neutral-peptone. Carcasses were individually placed into plastic bags, 500 mL of the pH adjusted peptone was added, the carcasses shaken for 1 min, and pre-incubation pH measured. Carcasses with rinse solution were incubated at 37 C for 24 h and presence of salmonellae determined. The pH of the pre-incubation enrichment peptone was 8.4 for the TSP neutral-peptone, 7.2 for the TSP acidified-peptone, 8.7 for the no TSP alkali-peptone, and 7.1 for the no TSP neutral-peptone. Salmonellae were detected from 50% of the TSP neutral-peptone carcasses, 50% of the TSP acidified-peptone carcasses, 63% of the no TSP alkali-peptone carcasses, and 43% of the no TSP neutral-peptone carcasses.

Key Words: Trisodium Phosphate, Salmonellae, pH

317 Recovery of bacteria from broiler carcasses rinsed 0 or 24 hours after chilling. J. A. Cason*, M. E. Berrang, and D. P. Smith, *Russell Research Center, Athens, GA*.

The PR/HACCP rule for poultry processing requires that selected carcasses be tested for numbers of E. coli or presence of Salmonella in carcass rinse samples taken immediately after chilling. The results are compared against microbiological standards or criteria based on the 1996 broiler chicken baseline data, but carcasses in that study were shipped to a lab and were rinsed the following day. To test whether carcass rinses done immediately after chilling are comparable to rinses 24 h after chilling, 20 whole broiler carcasses exiting the chiller of a poultry plant were sampled on 3 days. Carcasses were bagged aseptically and rinsed for 1 min in 400 ml of sterile water. Recovered rinse liquid was poured into a sterile container, rinsed carcasses were placed in clean plastic bags, and all materials were held overnight at 4 C. On the following day all carcasses were rinsed again in 400 ml of sterile water as before, and all rinse samples were cultured by standard methods to enumerate coliforms, E. coli, and Campylobacter, and to determine incidence of Salmonella. Statistical analysis used paired comparisons between the same carcasses rinsed at 0 or 24 h after chilling, with numbers of bacteria expressed as log cfu/ml of rinse. Significantly higher numbers of coliforms (3.0 versus 2.7) and E. coli (2.7 versus 2.4) were found in the rinse samples taken immediately after chilling versus rinse samples done at 24 h. There were no differences in numbers of Campylobacter (mean 1.8) or incidence of Salmonella between rinses taken at 0 or 24 hours. More study is required to determine whether rinse sampling of carcasses done at 0 and 24 h after chilling are microbiologically equivalent.

Key Words: Carcass Rinse, Coliforms, E. coli

318 Comparison of plate media for direct enumeration of *Campylobacter* spp. from carcasses rinses. K. S. Macklin*, R. S. Miller, and O. A. Oyarzabal, *Auburn University, Auburn, AL*.

Six plate media, Campy-Cefex (CC), modified Campy-Cefex (mCC), Campy-FDA (CF), charcoal cefoperazone deoxycholate agar (CCDA), Campy-Line (CL), and Karmali agar (K) were compared for their effectiveness in isolating *Campylobacter* spp. from commercial broiler carcass rinses. The modifications in mCC were as follows, the replacement of cyclohexamide with amphotericin B and the use of locally available whole lysed horse blood instead of commercially obtained laked horse blood. Carcass rinses were taken post-chill from four different processing plants (A, B, C, D), with 20 carcass rinses collected per plant visit. A standard rinse technique with 400 ml of buffered peptone water and one minute shaking was used for all samples collected. For each sample and each plate type, two 0.10-ml spread plates and four 0.25-ml spread plates were made. Plates were incubated at 42C under microaerophilic

conditions for 48 h. Suspect colonies were counted, examined under phase contrast microscopy and confirmed with a multiplex PCR for differentiation of *C. jejuni/C. coli*. The mean log CFU/ml count for each plate medium and for each plant was analyzed using GLM (P<0.05), and means analyzed for differences with Tukey's. Preliminary results from two visits to each plant indicate that the total number of positive plates for five of the media ranges between 41.3 to 48.8%; however the number was significantly lower for CL (28.1%). Mean log CFU/ml for the same five media as above were also similar (0.61 to 0.77), but again counts were significantly lower for CL (0.35). It appears that the composition of CL makes the medium too selective for isolation of low-temperature-stressed *Campylobacter*. The average percent positive for each plant was: A 95%, B 80 %, C 50% and D 0.5%. Mean log CFU/ml for each plant was: A 0.82, B 0.95, C 0.82 and D 0.01. More samples will be collected to determine if the low count and incidence of *Campylobacter* spp. in plant D remains consistent.

Key Words: *Campylobacter* spp., Media, Processing

319 Transfer of *Salmonella* and *Campylobacter* from stainless steel to a ready-to-eat food. C. M. Moore[1], B. W. Sheldon*[2], and L. Jaykus[1], [1]*Department of Poultry Science, North Carolina State University, Raleigh,* [2]*Department of Food Science, North Carolina State University, Raleigh.*

The degree of transfer of *Campylobacter jejuni* and *Salmonella enterica* serovar. Typhimurium was evaluated from a stainless steel contact surface to a ready-to-eat food (RTE, lettuce). Stainless steel coupons (25 cm^2) were inoculated with a 20 μl drop of either *C. jejuni* or *S.* Typhimurium to provide an inoculum level of ca10^6 CFU per 28mm^2. Wet and dry lettuce (*Lactuca sativa* var. *longifolia*) pieces (9 cm^2) were placed onto the inoculated stainless steel surface for 10 s after the designated inoculum drying time (0 to 80 min for *C. jejuni*; 0 to 120 min for *S.* Typhimurium), which was followed by recovery and enumeration of transferred pathogens (lettuce) and residual surface pathogens (stainless steel coupons). For transfers of *S.* Typhimurium to dry lettuce, there was an increase from 36% to 66% in the percent transfer of the initial inoculum load over the first 60 min of sampling followed by a precipitous drop from 66% to 6% in percent transfer. The transfer of *S.* Typhimurium to wet lettuce ranged from 23 to 31%, with no statistically significant difference between recoveries over the entire 120 min sampling period. For *C. jejuni*, the mean percent transfer ranged between 16 to 38% for dry lettuce and 15 to 27% for wet lettuce during the 80-min sampling period. The results of this study indicate that relatively high numbers of bacteria may be transferred to RTE foods such as poultry and red meat products even 1 to 2 hours after surface contamination. These findings can be used to support future projects aimed at estimating the degree of risk associated with poor handling practices of RTE foods.

Key Words: Ready-to-Eat Foods, Cross-Contamination, Foodborne Pathogens

320 Effect of packaging and electron beam irradiation on poultry safety and quality during extended storage. T. M. Preder*, S. J. Lewis, A. Velasquez, and S. R. McKee, *Auburn University, Auburn, AL.*

Electron beam irradiation (EB) combined with packaging was investigated as a means of extending the shelf-life of skinless, boneless chicken breast fillets (n=240 packages) stored at 4 C. Fillets were subjected to EB dose of 0.8 kGy and stored under aerobic or vacuum-packaged conditions for up to 42 days at 4 C. Weekly up to day 42, 5 packages of breast fillets (4 fillets per package) were randomly selected from each treatment group and subjected to microbial and sensory analyses. At day 0, EB completely eliminated coliforms and generic *E. coli* as well as *Salmonella* and *Campylobacter*. During storage, coliforms increased in non-EB fillets, but generic *E. coli* began to decline in non-EB fillets by day 21 of storage. Psychrotrophs and total aerobic bacteria were not completely eliminated by EB, but levels were lower (P #8804 0.05) in EB samples when compared to non-EB samples. As fillet storage time increased, psychrotroph and aerobic bacteria levels increased in both non-EB and EB fillets. However, increases in population counts for EB fillets were lower (P < 0.05) when compared to non-EB. Color determination indicated that EB fillets had higher "a" values when compared to non-EB fillets. As storage time increased, aerobically packaged non-EB fillets had higher "a" values than EB fillets. Consumer taste panels were conducted up to 42 days for EB fillets, but non-EB fillets were only tested up to 14 days because of high microbial levels. Results suggested that EB did not affect the appearance, flavor, or overall acceptability of fillets compared to non-EB fillets. Overall, the shelf-life in the irradiated fillets was three times higher when compared to the non-irradiated fillets.

Key Words: Electron Beam Irradiation, Shelf-Life, Vacuum-Packaging

321 The relationships among measures of albumen height, pH, and whipping volume. F. G. Silversides*[1,2] and K. L. Budgell[3], [1]*Pacific Agri-Food Research Centre, Agassiz, British Columbia, Canada,* [2]*Crops and Livestock Research Centre,* [3]*Nova Scotia Agricultural College.*

Defining quality has posed difficulties for the egg industry and measures of albumen height have been used extensively because albumen height is easily measured and decreases with time in storage. The association between albumen height and functional characteristics of the albumen is less clear. A total of 2,123 eggs were obtained from Brown Leghorn, unselected since 1965, ISA-Brown, a commercial brown egg layer, and Babcock B300, a commercial white egg layer, hens at 32, 50, and 68 weeks of age and used to investigate relationships among measures of albumen quality and a functional property of albumen. The eggs were sampled fresh and after storage for five and 10 days. At sampling, eggs were weighed and broken, and albumen height, pH, and volume after whipping for 80 seconds were measured. The yolks and dried shells were weighed, and albumen weight was determined by difference. Egg weight and the weights of the albumen and yolk increased with increasing age of the hen, with yolk weights increasing proportionately more. With storage, egg and albumen weights decreased, while yolk weight increased. Eggs from Brown Leghorn hens were smallest, but had proportionately the largest yolks. Albumen height decreased with time in storage and albumen pH and whipping volume both increased. Differences between lines suggested that commercial selection has changed the proportion of the yolk, albumen, and shell, and increased the albumen height. Albumen height and whipping volume were negatively correlated (r = -0.29), and differences between lines (whipping volume of albumen from Brown Leghorn eggs was greater than that of the other two lines) suggest that selection for increased albumen height could have decreased the foaming ability of albumen, which is a principal reason for including eggs in many processed food products.

Key Words: Albumen Quality, Layer Strain, Egg Storage

322 National Egg Temperature Survey: 3. Transport. K. E. Anderson*[1], P. H. Patterson[2], K. W. Koelkebeck[3], M. J. Darre[4], J. B. Carey[5], D. U. Ahn[6], R. A. Ernst[7], D. R. Kuney[8], and D. R. Jones[9], [1]*North Carolina State University, Raleigh,* [2]*Penn State University, University Park,* [3]*University of Illinois, Urbana,* [4]*University of Connecticut, Storrs,* [5]*Texas A&M University, College Station,* [6]*Iowa State University, Ames,* [7]*University of California, Davis,* [8]*University of California, Riverside,* [9]*USDA-ARS, Athens, GA.*

The Egg Safety Action Plan, raised many questions concerning egg temperature patterns used in the risk assessment model. Therefore, a national study was initiated to determine the extent of egg temperature changes from oviposition through distribution. Researchers composed of Extension Specialists and USDA-ARS, in CA, CT, GA, IA, IL, NC, TX, and PA gathered data on internal and external egg temperatures from commercial egg production, processing, and distribution facilities. The main effects were: geographic region, season, and type of operation. Transport data were recorded from lots of eggs from the processor to the point of resale or distribution. Comparisons between long and short hauls, and seasons were evaluated and geographic region was eliminated due to the movement between regions. A mixed model design was used; random effect of season, and the fixed effect for the transport duration (long or short haul). Information on the use of refrigerated transport trailers as short-term storage was evaluated. Egg temperature was not reduced during short term storage. The decrease in egg temperature was smaller (P < 0.0001) during short hauls 0.6 C than during long hauls 7.8 C. There was a significant season by haul interaction (P < 0.01) for internal egg temperatures. In the winter, egg temperatures during long and short deliveries were very similar at 10.5 and 13.4C compared to summer when egg temperatures were 11.0 and 22.7 C, respectively. Mean egg temperatures declined during transport similarly during the summer and winter and the temperature differential between

ambient and egg temperatures was only 0.4 C from the start to the end of the delivery. Refrigerated trailers used for short-term storage should be critically evaluated since egg temperatures are not appreciably reduced during this time period. These data suggest that the season of year affects the temperature of eggs during transport and are appreciably cooled on the truck, during the delivery phase. This should be a component in future assessments of egg safety.

Key Words: Egg transport, Egg temperatures, Shell eggs

323 Impact of commercial processing on the microbiological safety and quality of shell eggs. M. T. Musgrove*[1,2], D. R. Jones[1], J. K. Northcutt[1], M. A. Harrison[2], and N. A. Cox[1], [1]*USDA-ARS,* [2]*University of Georgia, Athens.*

Egg shell microbiology has been studied extensively over the years though little of it describes how modern U.S. processing conditions impact bacterial populations. As food safety regulations (e.g., sanitation/HACCP) are being drafted for the industry, such information can be important in determining processing steps most critical to product safety. Five different shell egg surface populations (aerobic, yeasts/molds, *Enterobacteriaceae*, *E. coli*, and *Salmonella* spp.) were monitored at 12 points along the processing line (accumulator, pre-wash rinse, washer one and two, sanitizing rinse, dryer, oiler, scales, re-wash belt entrance and exit, and two packer lanes). Three commercial in-line facilities were visited 3 times allowing for the sampling of 990 eggs that subsequently yielded 5,220 microbial samples. Variations existed in levels recovered from plant to plant but the patterns of fluctuations were similar for each population. Aerobes, yeasts/molds, *Enterobacteriaceae*, and *E. coli* populations were reduced by 30%, 40%, 75% and 50%, respectively, by the end of processing. Log_{10} counts/ml rinse on eggs collected from packer lanes were decreased by 3.2, 0.8, 1.4, and 0.5, respectively, when compared to rinses from eggs collected at the accumulator. *Salmonella* were recovered from 0 to 48% of pooled samples in the nine replications. More *Salmonella* were recovered from pre-processed (accumulator, pre-wash, re-wash belts) than in-process (washers, sanitizing rinse, dryer, oiler) or ready to pack eggs (scales, packing lanes). These data demonstrate that current commercial practices decrease microbial contamination of egg shell surfaces.

Key Words: Shell Eggs, Processing, Bacteria

324 Identification of *Enterobacteriaceae* and related organisms from rinses of eggs collected during processing in commercial shell egg processing plants in the southeastern United States. M. T. Musgrove*[1,2], D. R. Jones[1], J. K. Northcutt[1], N. A. Cox[1], and M. A. Harrison[2], [1]*USDA-ARS,* [2]*University of Georgia, Athens.*

Shell egg processing guidelines have been established to ensure that external and internal egg characteristics are of suitable quality. However, less is known about shell egg safety. To determine which enteric bacteria enter egg packing plants and persist through processing, eggs were collected from 3 commercial shell egg in-line processing plants on 3 separate visits. During each plant visit, 12 eggs were collected from each of 12 sites along the processing line: accumulator, pre-rinse, 1st and 2nd washer, sanitizing rinse, blower, oiler, check detection/scales, 2 egg packer lanes, re-wash belt entrance and exit. Each egg was sampled by a rinse technique and rinsate was plated onto violet red bile glucose agar with overlay for the detection and enumeration of *Enterobacteriaceae*. From each positive plate, up to 5 colonies were randomly selected and isolated for further analysis. Using biochemical tests, isolates were identified to genus or species. Sites for which the greatest numbers of isolates were identified were those collected from eggs during pre-processing. Sites yielding the least number of isolates were those during or at the end of processing. *Escherichia coli* and *Enterobacter* spp. were isolated from all of the nine plant visits. Other genera isolated from at least one of the three plants included *Cedecea*, *Citrobacter*, *Erwinia*, *Hafnia*, *Klebsiella*, *Kluyvera*, *Leclercia*, *Morganella*, *Proteus*, *Providencia*, *Rahnella*, *Salmonella*, and *Serratia*. Non-*Enterobacteriaceae* isolated and identified included *Aeromonas*, *Chryseomonas*, *Listonella*, *Pseudomonas*, *Sphingobacterium*, *Vibrio*, and *Xanthomonas*. All genera and species were recovered less frequently from processed eggs than from unwashed or in-process eggs. These data indicate that shell egg enteric bacteria are reduced as a result of commercial processing procedures currently being used.

Key Words: Shell Eggs, Processing, Enterobacteriaceae

325 Specific activity and stability of β-n-acetylglucosaminidase and lysozyme in extracted egg shell membranes as influenced by layer breed and storage variables. G. J. Ahlborn* and B. W. Sheldon, *North Carolina State University, Raleigh.*

In past studies, eggshell membrane (ESM) bound enzymes (lysozyme and β-N-acetylglucosaminidase, BNAG) or other components successfully reduced the thermal resistance of bacterial pathogens (83-87% reduction in D-values for *S.* Typhimurium, *S.* Enteritidis, and *E. coli* O157:H7). The ESMs are readily extractable and might be used as "natural" processing adjuvants for reducing bacterial heat resistance in foods or pharmaceuticals. Our objective was to investigate how layer breed, age, and processing methods affected ESM enzyme activity over time. Fifty eggs each from White Leghorn (WL) and Rhode Island Red (RIR) layers were washed, emptied, and rinsed. Membranes were carefully removed and twenty 4.7 mm dia. samples cut from each egg. Pooled samples were treated as follows: storage at 4°C, at -20°C, lyophilized, or dried at ambient temperature (ca23°C for 72 h) or at 50°C for 36 h in a convection oven. Samples were stored in airtight containers and enzymatic activity determined at 24 h post processing and after 1, 2, 4 and 6 months. Colorimetric change of 4-nitrophenyl N-acetyl-β-D-glucosaminide was used to evaluate BNAG activity and change in OD at 450 nm with *Micrococcus lysodeikticus* was used to evaluate lysozyme activity. After 24 h, BNAG activity was greatest in frozen samples. Fresh, refrigerated, and freeze-dried ESM exhibited slightly lower but similar activities. Both air and oven drying yielded significant reductions in activity (22 and 34% respectively) but remained constant thereafter. During extended storage (1 to 6 mo), the freeze-dried samples had no significant reduction in activity, while the frozen samples had a 20% loss after 6 mo. Fresh samples quickly degraded and were spoiled after two months. Lysozyme activities were similar to BNAG. Moreover, eggs from WL had up to 20% more enzymatic activity than those from RIR layers. These findings will be useful in further assessing the potential value of and applications for using ESM.

Key Words: Eggshell Membrane, Beta-N-Acetylglucosaminidase, Lysozyme

326 The effect of layer age, storage and strain of hen on egg quality during summer season under Sohag conditions. T. El-Sheikh*, *Faculty of Agriculture, South Valley University, Sohag, Egypt.*

A total of 600 eggs from 32 and 60 week old Hy-line-White, Hy-Line-Brown and Fayoumi hens were used after lay and after periods of storage of 0, 3, 6, 9 and 12 d at room temperature (30.2°C). Eggs were individually weighed. The yolk of each egg was cautiously separated from albumen and dried. Albumen weight was calculated by difference. Shell thickness was measured using a shell thickness gauge at three different locations on the egg shell. Albumen height was measured using a micrometer. Longer periods of storage resulted in significantly ($P<0.05$) lower albumen weight (64.28, 63.55, 62.69, 61.94, and 61.62 % for 0 to 12 d of storage) and albumen height (9.46, 8.10, 6.69, 5.45, and 4.58, for 0 to 12 d of storage) and higher albumen pH (7.35, 8.49, 9.10, 9.35, and 9.47, for 0 to 12 d of storage) across the two age groups. Eggs from Hy-line-Brown hens had more albumen and shell than those from Hy-line-White and Fayomi hens. The lower albumen weight and height with increased days of storage were not as pronounced in Fayoumi eggs compared to Hy-line-White and Hy-Line-Brown. Within each line and storage period, the egg weight was more closely associated with albumen weight than with yolk or shell weight. The albumen height of eggs from Hy-line-White hens was lower than those of Hy-line-Brown and Fayomi hens at all storage times, but the albumen pH was higher in either Hy-line-White and Hy-line-Brown compared to Fayoumi. The loss in weight from shell, albumen and yolk was increased with age. The changes in egg composition with storage time and age were solely the consequence of weight loss from the albumen.

Key Words: Fayoumi, Egg Quality, Egg Components