that all main variables (Phytase, Virginiamycin & Sex) had a significant (P<0.05) effect on body weight gain. Male broilers and those supplement- ed with Phytase or Virginiamycin were heavier than female broilers and those not supplemented with Phytase or Virginiamycin. Phytase and Virginiamycin also had a significant (P<0.05) effect on feed convers- ion. Broilers fed diets supplemented with Phytase or Virginiamycin had better feed conversion. In experiment 2, dietary supplementation with Phytase or Virginiamycin had a significant (P<0.05) effect on mortality. Broilers fed diets supplemented with Phytase or Virginiamycin had lower mortality.

Key Words: Virginiamycin, Phytase, Phosphorus utilization, Broiler chickens

51 Effect of phosphorus level, 25-hydroxycholecalciferol, and phytase supplementation on performance of male turkeys from 0 to 18 weeks of age. K.L. Thompson*1, T.J. Applegate*1, R. Angel2, K.M. Ondracek3, and P. Jaynes1, 1Purdue University, 2University of Maryland.

An experiment was conducted to determine the feasibility of lowering phosphorus levels when phytase and 25-hydroxycholecalciferol (25-OH D3) are added alone and in combination in diets for turkeys. Male, Nicholas poult's (5 pens/treatment, 12 birds/pen) were fed one of nine dietary treatments consisting of an industry diet (I) containing 0.7, 0.65, 0.6, 0.55, 0.45, and 0.4% non-phytate phosphorus (nPP); an NRC diet containing 0.6, 0.5, 0.42, 0.38, 0.32, and 0.26% nPP; or a diet containing 81% of the NRC requirement (diet L) of nPP (0.5, 0.42, 0.35, 0.32, 0.27, and 0.23% nPP; 8 pens/ per diet) from 0-3, 3-6, 9-12, 12-15, and 15-18 weeks, respectively. The I and NRC diets contained 0 or 600 FTY/kg phytase (nPP reduced 0.08%), 0 or 50 ug/kg 25-OH D3 (nPP reduced 0.03%), or a combination thereof. Birds fed the I and NRC diets (15 wk BW = 13.04 kg) were heavier (P < 0.005) from 0 to 15 weeks as compared with toms fed the L diet (15 wk BW = 11.90 kg). Dietary nPP concentration, however, did not significantly affect BW at 18 wk- of-age (average BW = 16.46 kg). BW gains of birds fed the L diet were 0.09, 0.17, and 0.35 kg less from 0-3, 3-6, and 6-9 wk-of-age as compared with birds fed the I or NRC diets (P < 0.05), but were not significantly different from 9-18 wk-of-age. Reductions of dietary nPP when 600 FTY phytase/kg and/or 50 ug 25-OH D3/kg were added to the diet did not significantly affect tom performance at any point during the course of the experiment. These results suggest that the concentration of phosphorus fed can be substantially reduced with supplemental phytase and/or 25- OH D3 with no detrimental effects on performance. In addition, NRC concentrations of nPP were adequate for support of growth throughout the trial, with toms fed nPP concentrations below NRC performing similarly from 9 to 18 wk of age.

Key Words: 25-hydroxycholecalciferol, Phosphorus, Phytase, Turkeys

52 Efficacy of Phytex phytase on phosphorus utilization and bone mineralization in turkey poult's. T.J. Applegate*1 and X.G. Le2, 1Purdue University, 2Cornell University.

A slope-response bioassay was conducted with male, Nicholas turkey poult's to determine the phosphorus (P) sparing effect of a new phytase product (Phytex; Phytex, LLC, Portland ME), based on improvements in bone mineralization, from 10 to 21 days of age. Reference diets for calculation of the sparing effect of P were formulated to contain 0.35, 0.43, 0.52, and 0.60% non-phytate phosphorus (nPP) and 1.2% calcium. Varying concentrations of Phytex phytase (0, 250, 500, 750, and 1000 U/kg) were added to the 0.35% nPP diet and improvements in bone mineralization were used to determine the sparing effect of P supplied from each level of phytase. The Phytex phytase premix was assayed for phytase activity prior to mixing. Phytase phytase supplementation did not significantly affect poult performance. The sparing effect of P was 0.141, 0.175, 0.19, and 0.194% P when calculated from tibia ash percent-age (quadratic effect; P < 0.05) and 0, 0.126, 0.126, 0.165, and 0.154% P when calculated from toe ash percentage (linear effect; P < 0.002) when Phytex phytase was supplemented at 0, 250, 500, 750, and 1000 U/kg, respectively. Similarly, the sparing effect of P was 0, 0.125, 0.198, 0.176, and 0.164% P when calculated from tibia ash weight (linear effect; P < 0.005) and 0, 0.138, 0.17, 0.125, and 0.124% P when calculated from toe ash weight (quadratic effect; P < 0.02) when Phytex phytase was supplemented at 0, 250, 500, 750, and 1000 U/kg, respectively.

Key Words: Bone ash, Phytase, Phosphorus, Turkey poult

Research was conducted to determine the effectiveness of chlorine dioxide gas (ClO2) for killing populations of bacteria on surfaces of eggs that are of concern to the poultry industry. Pathogenic bacteria (Salmonella Typhimurium, Listeria monocytogenes, and Staphylococcus aureus) and the indicator bacterium Escherichia coli, were applied to the surfaces of washed and sanitized eggs. Inoculated eggs were exposed to chlorine dioxide gas for 24 h in a 20 L container. The bags containing the chemicals used to generate ClO2 were designed to release a total of 2 mg ClO2 over 24 hours. The release profile of ClO2 was designed to yield 115 PPMV ClO2 (0.34mg/L), in the first hour and the balance 55 PPMV ClO2 (1.75 mg/L), was released at a constant rate over the next 23 hours. Bags were activated prior to placement in the pail and suspended from the lid, which contained a small electric fan. The pails were immediately sealed and placed at ambient (25 C) temperature for a period of 24 h. ClO2 gas completely eliminated all Salmonella Typhimurium on 0, 70, and 60 % of eggs in Reps 1, 2, and 3, respectively, and on eggs in which Salmonella Typhimurium survived, an average reduction of 5.77 log10 colony forming units (CFU) was achieved. The ClO2 gas treatment did not eliminate all Listeria monocytogenes on the eggshells, but a significant log10 reduction of 6.58, 6.11, and 6.27 was observed in Reps 1, 2, and 3, respectively. All Staphylococcus aureus were eliminated on 40, 30, and 30 % of eggs in Reps 1, 2, and 3, respectively, with an average log10 CFU reduction of 4.88. Escherichia coli were completely eliminated from 0, 60, and 60 % of eggs in Reps 1, 2, and 3, respectively, with an average log10 CFU reduction of 5.90. Even when very high concentrations of bacteria were inoculated onto eggs (1010 to 1012 cells/mL), ClO2 was found to be effective when applied as a gas for eliminating pathogenic and indicator populations of bacteria from egg shell surfaces. Application of chlorine dioxide gas to setters and hatchers may prevent cross-contamination of pathogenic bacteria from egg to egg and from egg shell to chick during the hatching process.

Key Words: chlorine dioxide gas, Salmonella Typhimurium, Listeria monocytogenes, Escherichia coli, eggs

54 The effect of two sanitizing agents applied using electrostatic spraying on pathogenic and indicator populations of bacteria on the surface of eggs. S. M. Russell*1, 1The University of Georgia.

Research was conducted to compare the effectiveness of two BioSentry sanitizers [BioSentry 904 (quaternary ammonium based sanitizer) and BioXII (hydrogen peroxide based sanitizer)] applied using an electrostatic spraying system (ESS) for killing populations of bacteria of concern to the poultry industry. Populations of pathogenic bacteria (Salmonella Enteriditis, Staphylococcus aureus, and Listeria monocytogenes) and indicator bacteria Escherichia coli were applied to eggs and allowed to attach for 1 h. Each egg was placed into a clean egg flat and positioned in an electrostatic spraying chamber. Tap water or stock solution was sprayed onto the eggs using two electrostatic spray nozzles for 20 s each for 6 h. After treatment, the eggs were allowed to dry under a laminar flow hood for 1 h. In addition, 2 eggs were dipped in each bacterial isolate, allowed to dry and stored for 6 h under a laminar flow hood as controls. Each control and treated egg was cracked using a sterile blade and the contents were removed. Eggshells and membranes were placed into 25 mL of sterile 1% peptone broth containing 3% Tween 80, 0.3% lecithin, and 0.1% his-tidine to neutralize the sanitizers. Three replicate trials were conducted. BioSentry 904 completely eliminated all Salmonella Enteriditis on 15 of 15, 14 of 15, and 9 of 15 eggs in Reps 1, 2, and 3, respectively. BioSentry BioXII completely eliminated all Salmonella Enteriditis on 15 of 15, 14 of 15, and 14 of 15 eggs in Reps 1, 2, and 3, respectively. BioSentry 904 completely eliminated all Staphylococcus aureus on 15 of 15, 13 of 15,
and 15 of 15 eggs in Reps 1, 2, and 3, respectively. BioSentry BioXH completely eliminated all Staphylococcus aureus on 15 of 15, 15 of 15, and 12 of 15 eggs in Reps 1, 2, and 3, respectively. BioSentry 904 completely eliminated all Listeria monocytogenes on 15 of 15 eggs in Reps 1, 2, and 3. BioSentry 904 completely eliminated all Escherichia coli on 14 of 15, 14 of 15, and 9 of 15 eggs in Reps 1, 2, and 3, respectively. BioSentry BioXH completely eliminated all Escherichia coli on 14 of 14, 14 of 14, and 14 of 15 eggs in Reps 1, 2, and 3, respectively. Both BioSentry 904 and BioXH were extremely effective when used in conjunction with electrostatic spraying for eliminating pathogenic and indicator populations of bacteria from egg-shell surfaces.

Key Words: electrostatic spraying, BioSentry 904 and BioXH, Salmonella, Escherichia coli, eggs


The desired color of poultry products varies among different markets. Two studies were designed to test the effect of feeding carotenoid pigments to poultry. In Study 1, Shaver 2000 laying hen eggs (24 wk of age) were fed a wheat-based diet with one of four treatments (no added pigment, Control; 10 g/tonne Carophyll yellow (CarY) + 10 g/tonne Carophyll red (CarR), Low; 25 g/tonne CarY + 10 g/tonne CarR, Medium; or 40 g/tonne CarY + 55 g/tonne CarR, High). Each diet was fed to three groups of 10 hens. Eggs were sampled on d 9, 2, 4, 6, 8, 10, 17, 20, and 26. Raw and cooked yolks were analyzed for apocarotenoid ester (APO) and canthoxanthin (CAN) by HPLC and yolk color was analyzed using both a Roche color fan and a HunterLab colorimeter. In Study 2, male Ross 308 chicks were fed a wheat-based diet with one of four treatments (no added pigments, Control; 200 g/tonne CarY + 5 g/tonne CarR, Low; 400 g/tonne CarY + 25 g/tonne CarR, Medium; or 700 g/tonne CarY + 50 g/tonne CarR, High). Each diet was fed to four pens of 10 chicks. Feed consumption and body weights were recorded weekly to 6 wk; the birds were killed and breast, thigh, and skin samples taken. Tissues were analyzed as in Experiment 1. There was no effect of treatment on egg production, egg weight, or feed conversion. Yolk APO and CAN content were higher in the High than the Control treatment (P < 0.05). Egg yolk pigments increased (P < 0.05) from day 0 to day 8, at which point they reached a plateau. Roche color fan and a* and b* values were higher for the High than the Control treatment for raw and cooked egg yolk. These values also increased with time up to, but not beyond 9 days. There was no effect of color treatment on broiler body weight, feed conversion, or mortality to 42 days. The APO and CAN content of raw tissue samples were higher in the High than the Control treatment. Similar results were observed for Roche color fan and b* values of raw tissues. Roche color fan and a* values increased with supplementation for cooked breast and thigh muscle, raw breast muscle and skin samples, but not raw thigh muscle. The L* values were not affected by treatment. The addition of pigments to poultry diets is an effective way to alter the appearance of eggs and meat.

Key Words: broiler, laying hen, carotenoid, pigmentation

56 Effect of Termin-8® compound on the productivity of brown egg laying chickens and environmental microbial populations. K. E. Anderson*, B. W. Sheldon1, and K. Richardson2, 1NC State University, Raleigh, NC USA, 2Anitox Corporation, Lawrenceville, GA USA.

The egg industry is attempting to reduce the level of microbial contaminants S. enteridis as part of the proposed egg safety regulations. Feed represents a potential vehicle of microbial pathogens which can colonize the gastrointestinal tract. This microbial contamination can lead to egg and environmental contamination, and impairment of nutrient utilization by the hen. Feed treatments such as Termin-8®, a formulation of salicylic acids, formaldehyde, and natural terpenes eliminate the microbial contamination and could benefit the laying hen in two ways: reduced competition in the digestive tract between indigenous and feed-borne microorganisms competing to colonize the ceca and small intestine; and the possibility of lower microbial contamination levels in the environment and on the exterior or interior shell eggs. Three strains of brown egg layers, a total of 3,016 hens, were housed in 2 layer facilities with tri-deck cages housed at 310 and 413 cm²/hen. Each treatment combination of 3 strains, 2 densities, and control vs. Termin-8® were allocated to 8 replicates for a total of 96 replicates in the factorial design. Termin-8® was added during the mixing process at the feedmill at a rate of 2.72 kg/ton. Each load of feed was sampled upon delivery so that total aerobic microbial contamination rates could be determined. Production parameters, egg weights, and USDA grades were collected from each replicate every 4 wk. Fecal, environmental swabs, and egg samples were collected every 8 wk. Inclusion of the Termin-8® feed treatment reduced (p < 0.0001) feed consumption by 0.3 kgfeed/100 hens and increased (p < 0.0001)egg numbers by 6 eggs/hen. The environmental microbial populations were similar and populations on the shell surface were 4,898 and 3,631 CFU/m² of egg wash for the control and Termin-8® treatment, respectively. The use of Termin-8® feed treatment improved the hen productivity with no change in the environmental microbial populations.

Key Words: Layers, Shell eggs, Antimicrobial feed additive, Microorganism

57 Survey of shell egg processing plant sanitation programs: 1. Egg contact surfaces. D. R. Jones1, J. K. Northcutt1, K. E. Anderson2, P. A. Curtis3, D. L. Fletcher4, N. A. Cox1, and M. T. Musgrove4, 1USDA-ARS, Russell Research Center, Athens, GA, 2North Carolina State University, Raleigh, NC, 3Auburn University, Auburn, AL, 4The University of Georgia, Athens, GA.

Sanitation standard operating procedures (SSOPs) are an integral component of food safety regulations. It has been determined that a complete analysis of shell egg processing facility sanitation programs has not been performed. The objective of this study was to assess and compare the efficacy of sanitation programs utilized in a variety of shell egg processing facilities. In-line, off-line, and mixed operations were included. Sixteen different direct or indirect egg contact surfaces were sampled in an assortment of shell egg processing facilities in the southeast U.S. Direct contact surfaces were those where water from these surfaces is sprayed onto the eggs. Sterile phosphate buffered saline soaked gauze pads were used for sampling. Samples were collected at the end of a processing day (POST) and again the next morning before operations began (PRE). Total aerobic plate counts (APC) and enterobacteriaceae (VRBB) were enumerated. No significant differences (P > 0.05) were found between POST and PRE bacterial counts for the 16 sampling sites. A high degree of contamination was considered to have counts greater than 10⁴ cfu/mL. In general, high APC were found on the wall of the recirculating water tank both POST and PRE. The re-wash belt had greater APC for all plants sampled. High APC counts were also found on the suction cups for the off-line loader. The APC counts for washers and washer brushes were relatively low for most plants sampled. Plant sanitation, as determined from direct microbial plating, could be improved. It is also important to note that previous research has found bacterial contamination counts of shell eggs to be extremely low, so stringent SSOPs may not be as necessary for the shell egg industry to produce a safe product.

Key Words: Shell eggs, Sanitation, Processing

58 Survey of shell egg processing plant sanitation programs: 2. Non-contact surfaces. D. R. Jones1, J. K. Northcutt1, P. A. Curtis2, K. E. Anderson2, D. L. Fletcher3, N. A. Cox1, and M. T. Musgrove4, 1USDA-ARS, Russell Research Center, Athens, GA, 2 Auburn University, Auburn, AL, 3North Carolina State University, Raleigh, NC, 4The University of Georgia, Athens, GA.

In addition to direct and indirect contact surfaces, non-contact surfaces can also serve as a source of cross contamination in the shell egg processing industry. The objective of this study was to assess and compare the efficacy of sanitation programs utilized in a variety of shell egg processing facilities. In-line, off-line, and mixed operations were included. Fourteen different non-contact surfaces were sampled in an assortment of shell egg processing facilities in the southeast U.S. Non-contact surfaces are defined as those where water from the shell surface or with fluid from that surface. Sterile phosphate buffered saline soaked gauze pads were utilized for sampling. Samples were collected at the end of a processing day (POST) and again the next morning before operations began (PRE). Total aerobic plate counts (APC) and enterobacteriaceae (VRBB) were enumerated. No significant differences (P > 0.05) were found between POST and PRE bacterial counts for any
of the 14 sampling sites. Counts greater than $10^4$ cfu/mL were considered to be high. In general, high APC were found on the floor under the farm belt (in-line and mixed operations) both POST and PRE. The drain had greater APC for all plants during POST sampling. Many facilities reduced these high numbers during sanitation procedures. High APC were also found on the wheel surface for off-line carts both POST and PRE. The loading dock floor also had greater APC both POST and PRE. In conclusion, non-contact surface sanitation counts suggest the need for better planning for sanitation programs. Changes in movement of equipment through the processing plant could help to reduce the high counts found on floor surfaces. Dedicated pallet jacks and pallets for off-line coolers to minimize cart travel in the facility could also reduce floor bacterial counts.

**Key Words:** Shell eggs, Sanitation, Processing

59 Incubation of egg contents pools for rapid detection of *Salmonella enteritidis*. Richard K. Gast* and Peter S. Holt, USDA-ARS, Southeast Poultry Research Laboratory.

Detecting contamination with *Salmonella enteritidis* is a pivotal aspect of efforts to ensure the microbial safety of eggs. Because contaminated eggs are apparently laid infrequently, eggs are usually pooled for sampling. A preliminary incubation period for these pools is often employed to allow small bacterial numbers to multiply to more easily detectable levels. Consistent detection of *S. enteritidis* in egg pools by multiple-step enrichment culturing methods requires the initial pool incubation to yield at least $10^6$ cells per ml, whereas more rapid methods can require as many as $10^7$ cells per ml. The present study determined the rates at which initial inocula of approximately 10 *S. enteritidis* cells multiplied in 10-egg pools, some of which were supplemented with concentrated broth media or with a source of iron. At 37°C, *S. enteritidis* levels usually grew to $10^7$ cells/ml within 9 hours in supplemented egg pools, but 15 hours were required to reach the same levels in unsupplemented pools. Similarly, *S. enteritidis* multiplication to levels of $10^8$ cells/ml was achieved in 15 hours in most supplemented pools, but usually required 24 hours in unsupplemented pools. At 25°C, the $10^7$ cells/ml level was attained within 18 hours in most supplemented pools, but not until 36 hours in unsupplemented pools. Likewise, most supplemented pools contained $10^6$ cells/ml after 36 hours of incubation, but 63 hours were necessary to support similar bacterial multiplication without supplementation. Accordingly, the length of incubation time necessary for consistent detection of small numbers of *S. enteritidis* in egg contents pools depends on the incubation temperature used, on whether the egg pools are supplemented to increase the rate of bacterial multiplication, and on the sensitivity of subsequent tests applied to the incubated pools.

**Key Words:** *Salmonella enteritidis*, eggs

60 Comparing Steam and Hot Water Treatment during Pasteurization of Fully Cooked and Vacuum Packaged Chicken Breast Strips. Rong Murphy1, L Duncan1, J Marcy1, N Kortola1, and R Wolfe1, 1University of Arkansas, 2FMC FoodTech.

Fully cooked chicken breast strips were surface-inoculated to contain $10^5$ cfu/g of *Listeria innocua*. Four hundred and fifty four grams of the inoculated product were vacuum packaged and treated via a pilot scale steam or hot water cooker at 88°C for a time period of 10 to 35 min. After treatment, the product was chilled with ice water and analyzed for the survivors of *L. innocua*. Parallel studies were also conducted using non-inoculated products to determine the heat treatments on water activity, expressible moisture, total moisture, and shear force. No significant difference was found on the survival rate of *L. innocua* between steam and hot water treatments. No significant difference was found on water activity and shear force among the treated and untreated products. However, significant difference was found on expressible and total moisture between treated and untreated products. When treated for 35 min in hot water, moisture was 9.1% and 30.4% lower, respectively, than that in steam treated and untreated products, and the total moisture was 3.7% and 5.4% lower, respectively, than that in steam treated and untreated products. This study is important in evaluating post-cook pasteurization treatment for ready-to-eat poultry products.

**Key Words:** thermal lethality, *Listeria*, pasteurization, fully cooked products, physical properties

61 Postcook Pasteurization to Reduce *Listeria monocytogenes* in Fully Cooked and Vacuum-Packaged Chicken Breast Meat Products. Rong Murphy1, M Berrang2, B Beard3, and N Kortola1, 1University of Arkansas, 2USDA-ARS, 3FMC FoodTech.

Three types of fully cooked chicken breast meat products (patties or strips) were surface-inoculated to contain approximately 8 log cfu/g of *Listeria monocytogenes*, vacuum-packaged in barrier pouches, and pasteurized via a pilot-scale steam or hot water cooker at 90°C for different lengths of time. The survivors of *L. monocytogenes* were enumerated on Modified Oxford agar medium overlaid with a thin layer of tryptic soy plus yeast extract agar medium. No significant ($α = 0.05$) difference was found on the survivors of *L. monocytogenes* between steam and hot water treatment. However, significant ($α = 0.05$) difference was found on thermal lethality of *L. monocytogenes* among the three types of the packaged products. In order to achieve 7 log cfu/g reduction for *L. monocytogenes*, the heat treatment time was about 36, 30, and 5 min for the packages containing 454 g strips, 227 g strips, and 120 g patties, respectively. This information is important for postcook pasteurization to eliminate *L. monocytogenes* in packaged ready-to-eat chicken products.

**Key Words:** *Listeria monocytogenes*, thermal lethality, pasteurization, fully cooked product, ready-to-eat

62 Decimal reduction values and z-values of *Escherichia coli* O157:H7 and Campylobacter jejuni on surfaces of bologna. L. Hughes1, B.W. Sheldon1, B.L. Dawson2, 1North Carolina State University, Raleigh, NC, 2Clemson University, Clemson, SC.

Cross-contamination of ready-to-eat luncheon meat with foodborne pathogens can occur post-processing prior to packaging. Because these types of products offer no additional heating prior to consumption, they constitute some degree of foodborne disease risk for consumers. To reduce the risk of disease from consuming contaminated ready-to-eat meat products, it may be feasible to apply a water immersion surface pasteurization process following packaging. To accomplish this goal the initial objective of this study was to estimate the decimal reduction times (D-values) and z-values of *Escherichia coli* O157:H7 (a mixture of HC 1840, HC 19486, HC 766 and ATCC 43894) and Campylobacter jejuni (a mixture of ATCC 72927, ATCC 71940, ATCC 36) by inoculating the surface of a lean turkey bologna (66.08% moisture, 13.76% fat, 11.00% protein, 2.71% ash). Inoculated 3.6 cm square bologna samples (three per package, single layer) were vacuum packaged in 22.0 x 15.3 cm bags and immersed in a circulating water bath for predetermined lengths of time. D-values for *E. coli* O157:H7 at 55, 60, 65, 70 and 75°C were determined, with survivors plated on Sorbitol MacConkeys agar (37C, 24h). D-values were 399.8, 46.8, 218.4, 9.4 and 7.9 seconds, respectively (z-value = 12.2°C). D-values for *C. jejuni* at 53, 55, 60, and 62°C were 283.1, 218.4, 53.6, and 24.1 seconds, respectively (z-value = 8.4°C). The recovery medium for *C. jejuni* was Campy Cefex agar (42°C, 48h, microaerophilic environment). These findings indicate that *C. jejuni* is slightly more heat sensitive than *E. coli* O157:H7. Moreover, the results of these heat inactivation studies provide the time and temperature parameters required to develop water immersion-based surface pasteurization processes for luncheon meats and other meat products such as hot dogs.

**Key Words:** *Escherichia coli* O157:H7, Campylobacter jejuni, D-values

63 In-package pasteurization combined with biocide-impregnated protein film to inhibit *listeria monocytogenes* and salmonella typhimurium in low fat ready-to-eat turkey bologna. Paul Dawson1, Kevin McCormick2, Inyee Han1, Brian Sheldon1, and James Acton1, 1Clemson University, 2Perdue Inc., 3North Carolina State University.

Concerns of the pathogens *L. monocytogenes* and *S. typhimurium* in ready-to-eat meat has received much attention. The ability of an in-package pasteurization method combined with the application of a nisin-containing wheat gluten film to reduce bacterial populations, and to prevent the subsequent recovery and growth of injured organisms during storage on the surface of low-fat turkey bologna was studied. The effects of pasteurization and nisin incorporated wheat gluten film were investigated to determine their effectiveness in preventing the growth of pathogenic microorganisms during the storage of the product. The in-package pasteurization treatment significantly reduced populations of both *L. monocytogenes* and *S. typhimurium* using a 6D processing method. The use of
the wheat gluten film with nisin was effective in reducing numbers of L. monocytogenes, but was ineffective against S. typhimurium. The combined treatment of nisin-containing film and in-package pasteurization substantially reduced the population of L. monocytogenes and prevented the recovery and outgrowth of cells during the two-month storage period. Growth of S. typhimurium not subjected to a treatment was limited or reduced during refrigerated storage while L. monocytogenes showed significant growth.

**Key Words:** Turkey bologna, Food Safety, In-package pasteurization, antimicrobial packaging, Listeria monocytogenes

### Environment & Management

#### Hatching Eggs & Other

64 The effects of feeding eight different dietary formulations on growth criteria in Bobwhite quail. G. S. Davis*1 and L. R. Miner2, 1NC State University, Raleigh, NC USA, 2Southern States Cooperative, Providence Forge, VA USA.

Approximately 20,000,000 Bobwhite quail (BQ) are produced each year in the US with the majority of these birds being raised and released on commercial hunting preserves. There is very little available information regarding the dietary requirements of BQ. Therefore, 2 studies were conducted simultaneously to examine production parameters of BQ provided 8 different dietary rations from 1 d to 10 wk of age. Each treatment group consisted of 90 BQ with 6 replications per treatment. Experiment 1 consisted of a 2 X 2 factorial arrangement of treatments: Extruded Soybean Meal (E-Soy) with 28% protein; Standard Soybean Meal (SSBM) with 28% Protein; E-Soy with 26% Protein; and SSBM with 26% Protein. Experiment 2 also consisted of a 2 X 2 factorial design: A control diet (E-Soy, 28% protein) with and without Bacitracin (BMD) (200 g/ton) versus a heat ready ration (HRR) (E-Soy, 28% protein) with and without the Direct-Feed Microbial, PrimaLac. Percent protein and E-Soy vs. SSBM only affected BW during the early stages of growth. BW of quail in HRR vs. control were heavier at 4, 6, and 9 wk. The presence of BMD or PrimaLac in the diets did not affect BW. However, BQ provided dietary PrimaLac had significantly (p < 0.05) better feather score at 10 wk. Cumulative feed conversion at 10 wk in BQ fed the SSBM was significantly improved (3.87) vs. that of the E-Soy treatment quail (4.01). It was concluded that PrimaLac in BQ rations improves feather quality and SSBM vs. E-Soy improves feed efficiency.

**Key Words:** Extruded soybean meal, PrimaLac, Feather quality

65 Effect of inoculation and application methods on the performance of chemicals used to disinfect Salmonella contaminated hatching eggs. M.T. Musgrove*1, N.A. Cox1, M.E. Berrang1, R.J. Buhr1, J.S. Bailey1, and J. M. Mauldin1, 1USDA-ARS, 2University of Georgia.

Salmonella can penetrate the shells and shell membranes of hatching eggs and this can critically affect final product contamination levels (processed broiler carcass). There have been numerous published studies on the efficacy of chemical disinfectants for hatching eggs. The objective of this study was to provide information that allowed the reader to accurately assess the published works on chemical efficiency to reduce salmonellae on hatching eggs. Three methods of inoculating the eggs were used: immersion, fecal smear, and droplet technique. Following inoculation, two different methods of applying the treatment were used: immersion and spraying. When an immersion inoculum was used at a high level (10⁶-10⁷), it was extremely difficult to demonstrate any reduction in Salmonella contamination of eggs with any chemical used. When the fecal smear was the method of inoculation, an effective chemical treatment dramatically reduced the number of Salmonella positive eggs with either an immersion or spray application. A relatively ineffective chemical showed no advantage over water. However, if a lower inoculum (10⁴) was applied by fecal smear then an immersion chemical or water treatment resulted in dramatic reductions in Salmonella positive eggs. With the droplet inoculum method at a moderate level (10⁴), immersion and spray applications produced dramatic reductions with either chemical tested. By this egg inoculation method, slight reductions were noted even when water was used as the disinfection treatment. Studies such as these can be easily biased and the reader should pay close attention to method and levels of inoculation and application before deciding on the efficacy of a chemical treatment.

**Key Words:** Salmonella, Disinfection, Hatching eggs

66 Identification of critical periods for turning broiler hatching eggs during incubation. O. Elbolb1 and J. Brakel2, 1University of Ankara, Ankara, Turkey, 2North Carolina State University, Raleigh, NC USA.

Broiler hatching eggs were collected four times daily and stored for 1-3 d at 18 C before being set in a commercial hatchery. All eggs were turned 24 times per day during incubation except as required for each specific treatment. In the single trial of Experiment 1, 7,200 eggs were either turned or not turned during the 0-7 d, 8-14 d, and 15-18 d periods in eight regimens that included all possible turning combinations. The absence of turning from 0-7 d of incubation caused the greatest decrease in fertile hatchability and greatest increase in all stages of embryonic mortality and the incidence of Malposition II (head in small end of shell).

A significant turning treatment by flock age interaction showed that the 0-7 d effect was more pronounced in the 08-wk-old flock as compared to the 29-wk-old flock used in the experiment. In the two trials of Experiment 2, 9,600 eggs from each of 33-wk-old (Trial 1) and 35-wk-old (Trial 2) broiler breeder flocks were either turned or not turned from 0-2 d, 3-4 d, 5-6 d, or 7-8 d in 16 regimes that included all possible turning combinations. Generally, the absence of turning from 3-8 d, or 0-2 d alone or in combination with other time periods reduced fertile hatchability and increased embryonic mortality and percentage Malposition II. The 3-8 d period has been typically associated with the formation of the subembryonic fluid while the 0-2 d period was apparently more associated with dynamics of the shell membranes and albumen. It was concluded that the most critical period for turning commercial broiler hatching eggs during incubation was from 0-7 d with the single most critical 2-d period being 0-2 d.

**Key Words:** Turning, Hatchability, Embryonic mortality, Broiler hatching eggs

67 Performance of Bobwhite quail fed different levels of protein and enzyme supplementation. J. P. Blake*, J. B. Hess, B. D. Bowers, and A. Corzo, Auburn University, Auburn, AL.

Native Bobwhite quail populations have declined almost 80% during the previous 40 years. As a result, about 20 million birds are produced commercially to fulfill hunting needs. Limited information exists concerning dietary requirements of Bobwhite quail and producers could benefit from such information. In Experiment 1, 240 one-week-old Bobwhite quail were divided among 4 treatment groups and randomized into 6 replications with 10 birds/rep. A 26% protein mash starter diet (2810 kcal ME/kg) was fed to 3, 4, 5, or 6 weeks of age followed by the introduction of a 20% protein mash grower diet (2810 kcal ME/kg) at the appropriate time and fed through 8 weeks of age. In Experiment 2, 240 one-week-old Bobwhite quail were divided among 4 treatment groups and randomized into 6 replications with 10 birds/rep. A 26% protein mash starter diet was fed from 1-6 weeks of age where dietary treatments were: Control, Allzyme Phytase (2 lb/ton), Bio-Mos Plus XCL (3 lb/ton), and Penicillin (20 g/ton). Birds were fed a 20% mash grower diet containing no additives from 6-8 weeks of age. Birds and feed were weighed weekly in both experiments. Results from Experiment 1 indicate that birds were significantly (P<0.05) smaller at six weeks of age when fed the starter diet to three or four weeks of age. However, by eight weeks of age bodyweight averaged 149 g/bird and no differences between treatments occurred suggesting that compensatory growth prevailed. Feed efficiency (feed/gain) averaged 4.37 for the seven-week experimental period while no significance among treatments occurred. Results indicate that Bobwhite quail are responsive to a decrease in protein intake, but respond to compensatory gain. Results from Experiment 2 indicate that the feed additives had no effect on improving bodyweight gain, feed efficiency, or mortality. By eight weeks of age average bodyweight and feed efficiency was 148/g/bird and 4.43, respectively. The feed additives failed to provide