2023 RESEARCH NEWSLETTER

USPOULTRY®
U.S. POULTRY & EGG ASSOCIATION

The All Feather Association progressively serving poultry and egg members through research, education, communications and technical services.

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2023 USPOULTRY RESEARCH

The U.S. Poultry & Egg Association (USPOULTRY) is the world's largest and most active poultry organization. USPOULTRY represents the entire industry as an "All Feather" Association. USPOULTRY is a nonprofit organization which represents its poultry and egg members through research, education, communication, and technical assistance. Membership includes producers and processors of broilers, turkeys, ducks, eggs, and breeding stock, as well as allied companies. Formed in 1947, the Association has member companies nationwide and affiliations in 28 states. USPOULTRY also sponsors the International Poultry Expo, part of the International Production & Processing Expo.

Send Comments to:
U.S. Poultry & Egg Association, 1530 Cooledge Road, Tucker, GA 30084-7303
info@uspoultry.org

USPOULTRY and Foundation Approve $738,000 in New Research Grants Through the Comprehensive Research Program

USPOULTRY and the USPOULTRY Foundation approved $738,000 for 10 new research grants at six institutions through the Comprehensive Research Program. The research funding was approved by the boards of directors of both organizations, based on recommendations from the Foundation Research Advisory Committee (FRAC). The FRAC evaluates research proposals to determine their value to the industry and then makes recommendations to the boards for funding. Committee members are professional specialists from different segments of the poultry and egg industry who represent a variety of disciplines.

The Association's Comprehensive Research Program dates to the early 1960s when funds were first approved for poultry disease research. It gradually grew into an all-inclusive program incorporating all phases of poultry and egg production and processing. Since the inception of the research program, USPOULTRY has reinvested more than $36 million into the industry in the form of research grants. More than 50 universities and federal and state facilities have received grants over the years. The Comprehensive Research Program projects are as follows:

Virus Isolation, Serological Surveillance and Mechanical Transmission of Egg Drop Syndrome
University of Georgia

Identifying Virulent Avian *Enterococcus Faecalis* Isolates by Using Matrix-Assisted Laser Desorption/Ionization – Time of Flight (MALDI-TOF) Mass Spectroscopy
University of Nebraska-Lincoln

Development of a Web-Based Artificial Intelligence System for Analyzing Broiler Activity Index
University of Georgia

Effects of Combined Sprinkler and Cool Cell Systems on Cooling Water Usage, Water and Feed Consumption Rates, Bird Performance and In-House Environment of Commercial Broiler Barns
Mississippi State University

Can Colony Nests Also Function as Floor Space for Cage-free Layers? Assessing Animal Welfare and Egg Quality Outcomes
North Carolina State University

DNA Immunization as a Safe and Economical Vaccination Strategy Against Infectious Laryngotracheitis Virus (ILTV) to Enhance Mucosal Protection in Primary Sites of Infection
University of Georgia (research grant made possible in part by an endowing Foundation gift from Fieldale Farms Corporation)

Use of Qualitative and Quantitative Microbial Data to Determine if Turkey Pre-Chill and Post-Chill Sampling Are Predictive of *Salmonella enterica* Contamination in Ground Turkey
Kansas State University (research grant made possible in part by an endowing Foundation gift from Cargill)

Discovery of Novel Anthelmintic Resistance Genes to Reduce Production Loss Caused by Blackhead Disease
Northwestern University (research grant made possible in part by an endowing Foundation gift from Pilgrim's)

Control of *Enterococcus cecorum* Through Identifying Its Dynamics of Adaptation to the Chickens and Its Environment
Mississippi State University (research grant made possible in part by an endowing Foundation gift from Wayne-Sanderson Farms)

Identifying a New Pre-Harvest Gold Standard *Salmonella* Sampling Strategy to Predict *Salmonella* Burden on Broiler and Turkey Flocks Arriving for Processing
University of Georgia (research grant made possible in part by an endowing Foundation gift from Prestage Farms)

USPOULTRY and Foundation Approve $250,000 in New Research Through the Board Research Initiative Program

USPOULTRY and the USPOULTRY Foundation have approved approximately $250,000 in funding for two new research grants at two institutions through the Board Research Initiative Program. The topics and request for proposals were selected by the USPOULTRY and Foundation boards of directors. The Foundation Research Advisory Committee evaluated several research proposals and then recommended which proposals to fund to the board.

The research grants are as follows, and the research funding was made possible in part by donations to the USPOULTRY Foundation. The donations came from a wide range of poultry and egg companies, individuals and families to support the Foundation's mission of funding industry research and recruiting students into poultry careers.

Investigation into the Contributions of Rooster, Hens and Social Dynamics on the Reduced Hatchability in Broiler Breeders
Auburn University (research grant made possible in part by an endowing Foundation gift from Mar-Jac Poultry Inc.)

Updated Decision Support Tool for Supplemental Heat Requirements in Barn Depopulation During an HPAI Outbreak
Iowa State University (research grant made possible in part by an endowing Foundation gift from MPS Egg Farms)

The USPOULTRY Board Research Initiative was created by the boards of USPOULTRY and the USPOULTRY Foundation to address current issues facing the poultry industry. The USPOULTRY Board Research Initiative operates alongside the USPOULTRY Comprehensive Research Program and augments the great success of the existing program by focusing additional resources toward defined areas of research.

Researcher Evaluates Potential Antibiotic Alternative Approaches for Controlling *Salmonella* in Poultry

Dr. Kichoon Lee

Department of Animal Sciences, The Ohio State University, Columbus, Ohio

Due to the reduced use of antibiotics in animal feeds, antibiotic alternatives need to be developed to prevent or minimize *Salmonella* infections. *Salmonella* colonizes within the avian intestine; therefore, approaches should be focused on reducing the intestinal *Salmonella* population. Avian defensins are antimicrobial peptides that are naturally secreted from the intestinal epithelial cells into the lumen. These defensins kill bacteria by forming pores and disrupting the bacterial membrane. Avian defensins have potent anti-bacterial activity. However, sequencing of the AvBD1 gene found two different variants that might have different antimicrobial activities, an assumption based on prediction modeling of the protein structure of the two variants.

This research project consisted of three objectives, 1) determine allele frequency of these AvBD1 variants in several major chicken breeds, 2) validate the most potent AvBD1 chicken genotype by challenging chickens (screened according to their AvBD1 genotype) with live *Salmonella* inoculations, and 3) assess synthetic AvBD1 variants for antimicrobial activity against *Salmonella.*

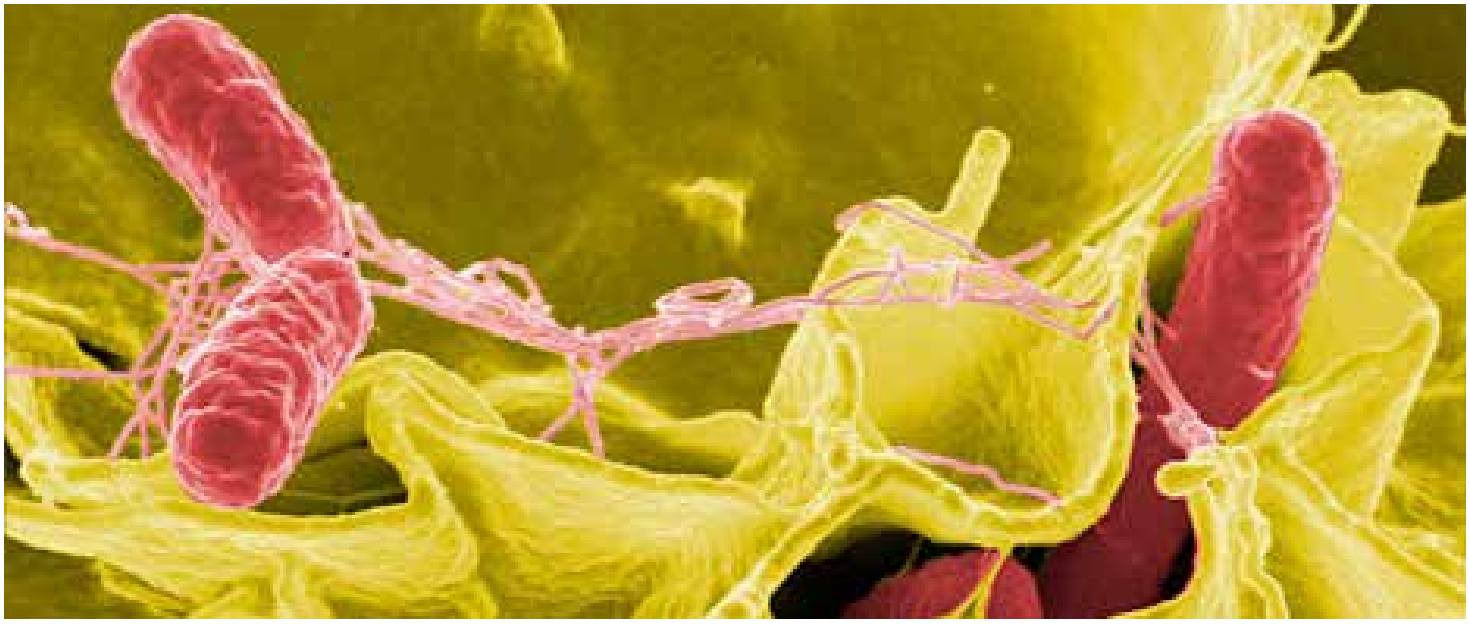
Researchers analyzed two batches of hatching eggs (300 broiler eggs and 400 leghorn eggs) for sequencing the AvBD1 gene. There were sequence variations in the AvBD1 gene that caused amino acid changes at the 35th, 45th and 57th positions. One population of chickens had serine, serine and tyrosine (SSY) at the three amino acid positions, respectively. Another population of chickens had asparagine, tyrosine and histidine (NYH) at the three amino acid positions, respectively. A third population consisted of heterozygous chickens exhibiting alleles for both SSY and NYH. The ratio of NYH: NYH/SSY: SSY in broiler breed #1 (150 eggs) was 1: 2.6: 1.4, respectively. The ratio in broiler breed #2 was 1: 6: 0, respectively. The ratio in the commercial white leghorns was 1: 0.57: 0, respectively.Interestingly, all commercial brown leghorn chickens had only SSY, a ratio of 0: 0: 1, respectively.

To validate the most potent AvBD1 chicken genotype by challenging chickens (screened according to their AvBD1 genotype) with live *Salmonella* inoculations, researchers identified several heterozygote (SSY/NYH) white leghorn chicks that served as breeding pairs. Breeding of SSY/NYH resulted in producing progenies with a 1: 2: 1 ratio of SSY: SSY/NYH: NYH, respectively. There was no difference in numbers of *Salmonella* in intestine among three different genotypes (SSY, SSY/NYH, NYH).

Two synthetic AvBD1 variants were also evaluated for antimicrobial activity against *Salmonella* in vitro. There was no difference in the anti-*Salmonella* effect between the two groups. However, the growth of *Salmonella* was lowered by 25 ug/ml compared to 1.56 ug/ml of both synthetic peptides, after four hours of incubation, indicating anti-*Salmonella* effect of both peptides with high concentrations.

The expected long-term impact was to help poultry breeders selectively breed chickens to have the most effective AvBD1 genotype; reduce the *Salmonella* population within the chicken gut; and produce a safer poultry product. Although variations were identified in AvBD1 proteins among chicken populations, the in vivo and in vitro data did not show differences in anti-*Salmonella* activities. This may be due to the possibility that avian defensins are more efficient against gram-positive bacteria than gram-negative ones, including *Salmonella* and *E. coli*.

The research was made possible in part by Simmons Foods.



Researchers Evaluate Methods to Improve *Salmonella* Surveillance in Turkeys

Dr. Nikki Shariat

Poultry Diagnostic and Research Center, University of Georgia, Athens, Ga.

Vaccine programs are a primary pre-harvest *Salmonella* mitigation strategy, and development of effective programs rely heavily on effective *Salmonella* serovar surveillance. Noteworthy hurdles to surveillance and vaccine program development includes the fact that traditional isolation identifies only the most abundant serovars in a population, while underlying serovars remain unknown. Further, there is a lack of understanding where in the supply chain samples should be taken to inform serovars present in the system.

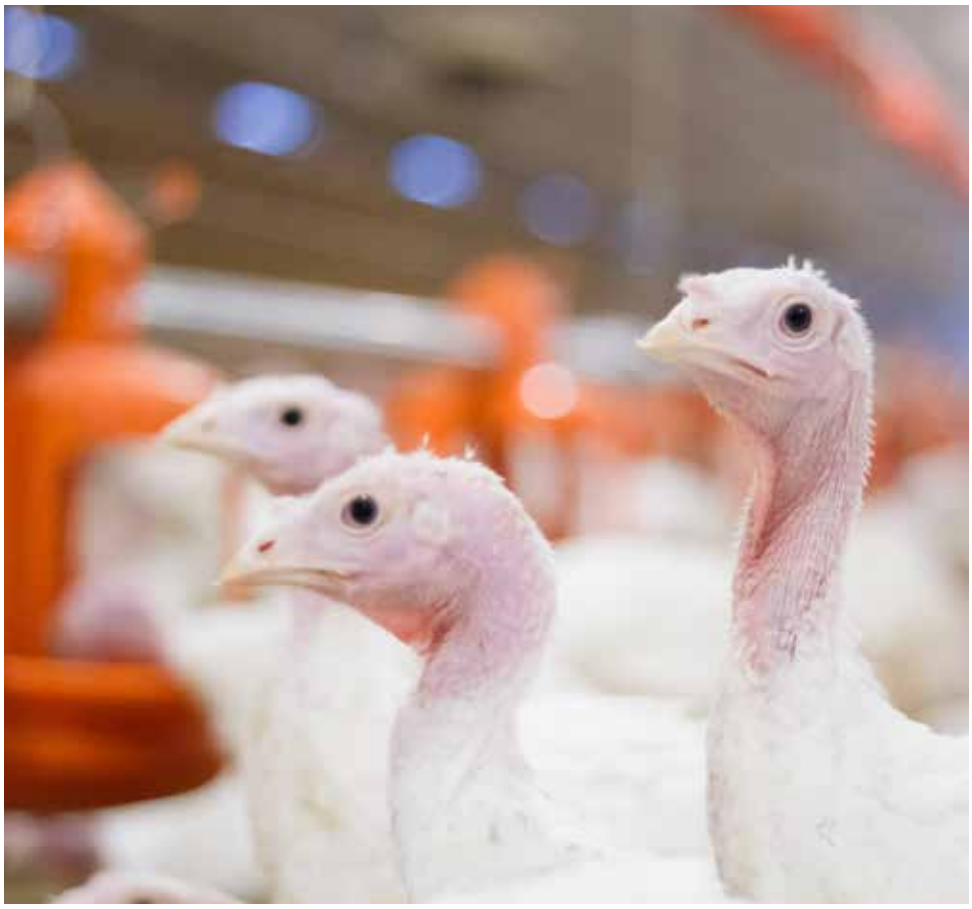
This completed project encompassed two objectives. The first objective was to use deep serotyping by CRISPR-SeroSeq, a molecular tool that maps relative *Salmonella* serovar frequencies to identify all serovar populations present in surveillance samples taken throughout a turkey production chain. The second objective was to use CRISPR-SeroSeq data to resolve significant differences observed in serovar prevalence between ground turkey and mechanically separated turkey (MST) at processing.

Findings from objective 1 revealed that on-farm *Salmonella* did not correlate with prevalence at processing, with less than half of the flocks that were positive at the plant being positive on the farm. *Salmonella* prevalence was reduced 3-fold during pre-chill interventions. Higher prevalence in MST and ground turkey compared to pre-chill samples suggests the release of internalized *Salmonella* during grinding. This is supported by deep serotyping that showed that in most flocks there was at least one serovar found in product (MST or ground turkey) that was not found upstream.

Objective 2 results indicated that *Salmonella* prevalence was higher in MST than in ground turkey samples, but the difference was not statistically significant across all flocks. However, deep serotyping with CRISPR-SeroSeq showed that MST product contained a larger number of *Salmonella* serovars on a per sample basis than ground turkey. A third of MST samples contained multiple serovars, while less than one in 10 ground turkey samples contain more than one serovar.

This is the first high-resolution study of *Salmonella* in turkey that investigates serovar populations through the supply chain. Completion of this work highlighted the complexity of this pathogen in turkey production and processing. The study demonstrates flocks are likely contaminated with multiple serovars, and effective surveillance should include samples taken at processing where prevalence and diversity are highest (pre-scald, MST). Tracking whole *Salmonella* serotype populations from grow-out farms to finished products provided a better understanding of *Salmonella* diversity, but more importantly, has highlighted that, 1) relying solely on USDA finished product sampling is not sufficient to provide informative feedback to breeders/hatcheries regarding serovars in the supply chain, 2) product from different bird parts can harbor different serovars, thus multiple product types should be sampled for surveillance purposes, and, 3) farm booties collected at the end of grow-out are not an effective sample to understand serovars present in a flock prior to slaughter. There is a need for alternative sample types or sampling times to capture *Salmonella*, as the sampling performed here was not indicative of the *Salmonella* found down-stream.

The research was made possible in part by an endowing Foundation gift from Cargill.



Researchers Evaluate Egg Wash Sanitizers to Reduce *Salmonella* Contamination on and in Turkey Eggs

Ted Brown

Cargill Scientific Services, Cargill, Inc., Wichita, Kan.

Salmonella remains the number one cause of foodborne illness in the U.S., which causes an economic burden for the poultry industry as well as public concern for the consumers. The poultry industry must be diligent at all steps of processing to reduce *Salmonella* risk, including interventions for hatch eggs. *Salmonella* is frequently found on hatch eggs even after the sanitization process. Chlorine is widely used by turkey breeders for egg sanitization. Although it can be an effective sanitizer, there are drawbacks to using it, such as: 1) chlorine dissociates quickly with presence of organic loads, 2) it can be very corrosive to equipment, and 3) ensuring chlorine is at effective levels requires strict management practices. While there are other well-known and more effective sanitizers available, many sanitizers can damage the egg cuticle and allow more bacteria to enter the egg. Prior studies have evaluated non-chlorine sanitizers, such as peracetic acid (PAA) and peroxide, as egg sanitizers. However, none of these trials evaluated the effect on the cuticle layer to ensure hatchability. There is a critical need to find an improved egg sanitization process to reduce *Salmonella* contamination in breeder eggs but not negatively impact hatchability. This project evaluated several new antimicrobials on the market as egg sanitization chemicals and assessed their impact on the egg cuticle.

Objective 1 used a *Salmonella* inoculation trial to determine the most effective hatch egg sanitizers to reduce *Salmonella* contamination on the external egg surface. The sanitizers evaluated included thymol, PAA, bromine, peroxide and quaternary ammonium. Chlorine (commonly used in the industry today) was included as a positive control, and an unwashed set of eggs served as the negative control. Sanitization efficacy was evaluated by inoculating the eggshell with *Salmonella*, treating the egg with each sanitizer wash treatment, shaking the washed eggs in a bag with sterile media, and measuring contamination by plating the rinsate and quantifying aerobic plate counts and *Salmonella* (Log CFU/egg by enumeration).

Objective 2 assessed the hatch egg sanitizers from Objective 1 on their ability to cause potential cuticle damage and allow *Salmonella* to penetrate the egg. Bacterial penetration into the egg was evaluated by inoculating the eggshell with *Salmonella*, treating the egg with each sanitizer wash treatment, and measuring transmission by plating the internal egg contents and quantifying *Salmonella* (Log CFU/g by enumeration). Egg penetration was also evaluated by a Blue Lake Dye test performed at one day of storage.

The peroxide product proved to be the most effective egg sanitizer at reducing *Salmonella* prevalence on the egg surface by more than 73%. Chlorine, quaternary ammonia, PAA and bromine all proved to be equally effective egg sanitizers by reducing *Salmonella* prevalence detected on the egg surface. PAA and bromine reduced *Salmonella* by 34% and 30%, respectively. This was slightly less than chlorine (reduction of 43%) and quaternary ammonia (reduction of 37%). The thymol product was the least effective sanitizer assessed in the study (only reduced *Salmonella* prevalence by less than 5%). All treatments reduced *Salmonella* levels on the surface of the inoculated eggs by three logs when compared to the unwashed treatment. When assessing aerobic plate counts, all treatments performed significantly better than thymol and bromine. Peroxide and quaternary ammonia were most effective at reducing aerobic plates counts, which demonstrated a 4.25 and 4.33 Log CFU/egg reduction, respectively.

The two methods utilized to assess the cuticle during the trial generated results demonstrating the sanitizers tested in this trial did not damage the cuticle and *Salmonella* did not penetrate the egg. A true hatchability trial should be completed to ensure hatch rates are not affected by the sanitizers assessed in this study.

In the short-term, this project produced updated information on new and current egg sanitizing washes to guide industry on the best process to mitigate *Salmonella* contamination in and on hatch eggs during the washing process at breeder facilities. Findings from this work are of direct relevance across the turkey industry, as well as the broader poultry industry.

The research was made possible in part by an endowing Foundation gift from Cargill.

Researchers Evaluate a Unique Lighting System to Assess Welfare and Skeletal Quality of Laying Hens

Dr. Darrin Karcher

Department of Animal Sciences, Purdue University, West Lafayette, Ind.

Laying hens require correct lighting for proper development and reproduction. However, there is limited research on the effects that different types of light have on the welfare and skeletal quality of the bird. A novel lighting source, Pulsed Alternating Wavelength System (PAWS), is being introduced to the industry and delivers light through a specific pattern of alternating wavelengths in nanosecond pulses. This lighting system may improve the growth rate of birds, decrease the age at first egg, and decrease aggressiveness and nervousness behaviors. However, there are no published studies on how PAWS affects production and the welfare of poultry. Increasing growth and decreasing age at first egg through the lighting source would be economically beneficial to laying hen producers. However, the unknown subsequent effect on the skeleton may have negative impacts on the bird, especially later in life when layers are more susceptible to keel bone fractures. Understanding the effects that PAWS has on the hen's welfare, physiology and skeleton are critical if this technology is to be used widely in the industry. A bone quality assessment method that has not been utilized in poultry, called reference point indentation (RPI) is also being tested. The project objective was to evaluate the effects of Pulsed Alternating Wavelength System (PAWS) on the welfare and skeletal quality of laying hens utilizing traditional bone quality assessment methods and RPI.

In the study, there were two PAWS flocks (PAWS1 and PAWS2) and a control flock used that were housed in conventional cages at a commercial facility. The physiological welfare of the hens was improved by PAWS lighting at the younger ages (22 and 32 weeks of age) as based on the reduced serotonin turnover ratios that the PAWS1 flock had compared to the control. There were more variable differences in the older ages (50 and 52 weeks of age), but overall, the older ages had much lower serotonin turnover ratios compared to the younger ages regardless of treatment. While the physical welfare results were more inconsistent, PAWS2 generally had decreased welfare quality scores across most parameters, especially feather coverage scores, while PAWS1 fluctuated more. However, PAWS2 did have reduced keel tip fractures at the post-peak production phases (50 and 52 weeks of age). When analyzing bone quality parameters between the peak (32 weeks of age) and post-peak (52 weeks of age) production phases, the control flock had decreased fracture force in the post-peak phase compared to the peak phase. The fracture force of PAWS1 flock remained constant between the phases. There were no treatment differences in bone ash percentage, but bone ash did decrease between the peak and post-peak production phases. When analyzing bone quality parameters between all three flocks at the peak production phase, digital bone mineral content (BMC) tended to be higher in PAWS2 compared to the control. The RPI outputs were lower in PAWS2 compared to PAWS1 and the control, which indicates superior bone quality. The fracture force was not different between treatments. Overall, PAWS lighting appears to improve both physiological and physical welfare as well as most bone quality parameters.

Short-range benefits for the laying hen industry include that PAWS lighting does not seem to have a detrimental effect on the welfare or bone quality of birds. Findings indicate that the industry can start implementing these lights without worry of harming the hens. Long-range benefits could include improved bone quality and welfare, which may lead to increased longevity and productivity of hens. Implementing these lights in cage-free production may aid in decreasing keel bone damage. However, much more research is required to delve into any potential benefits before there is industry-wide change.

The research was made possible in part by an endowing Foundation gift from MPS Egg Farms.

Researchers Investigate How Laying Hens Visually Perceive the Resources in Cage-Free Housing

Dr. Darrin Karcher

Department of Animal Sciences, Purdue University, West Lafayette, Ind.

Geneticists have been trying, with little success, to determine and select egg layer strains that will perform well in cage-free production systems because there are numerous unknown factors which influence a hens' performance. The unknown factors have resulted in there being no single strain that can perform consistently. Companies that have transitioned to cage-free production are faced with various management and welfare issues including keel bone damage, mislaid eggs and feet pecking. These new welfare issues may be due to the hens' inadequate or inaccurate perception of their environment due to inappropriate lighting. No previous studies in poultry have determined how lighting systems can impact hens' visual perception of their housing environment or of their conspecifics.

This project sought to achieve the following objectives: (1) develop a chicken-specific visual model through the collection of physiological information, (2) evaluate lighting systems for spectral properties among different cage-free housing in commercial settings, and (3) explore the relationship between avian visual perception and flock welfare outcomes. Initial data to develop the visual models was collected from laying hens housed at Purdue University. Researchers partnered with a commercial egg producer to collect light spectra during production in a cage-free housing facility. Models were executed to identify whether high or low conspicuousness of different objects from the hens' viewpoint could be related with variations in welfare indicators under different cage-free housing and lighting systems.

Due to the highly pathogenic avian influenza outbreak across the country during the project period, researchers were unable to visit as many facilities as addressed in objective 2 or assess the welfare indicators initially proposed in objective 3. However, they were able to fully develop the visual models from two strains of chickens (brown and white) at three different ages (17, 25, and 85 weeks of age) to model the visual environment at two different facilities.

The study showed that there are significant differences in the visual systems of brown and white chickens at all ages. The ability of light to transmit through the eye of both brown and white strains decreased with age, reducing the amount of ultraviolet light that reaches the retina. The relative density of cells in the retina consistently differed between the brown and white strains. The sensitivity of cells in the retina did not change with age, however there were unexpected differences found between the brown and white strains.

In cage-free egg laying facilities, modeling revealed that the visual environment is often homogeneous and undistinctive, except when highly colored objects are present, potentially increasing the risk of injury to the hens as they move through the aviary. The ambient light in the egg laying facility impacts how conspicuous objects and substrates are. In certain ambient light conditions, the strain and age of the laying hens determined if an object was easily perceived. Overall, variability in the visual systems of different strains and ages of laying hens should be considered when determining aspects of the visual environments that are utilized in the industry.

The research was made possible in part by an endowing Foundation gift from MPS Egg Farms.

Researchers Evaluate the Effects of Heat Stress in Poults

Dr. Rocio Crespo

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Many turkey poults may experience poor starting performance for reasons that are not well understood. Turkey flocks may even suffer mortalities up to 3% within the first three weeks of life. Factors, including delayed feeding, starvation, genetics and age of the parental flock have been investigated, but the true etiology remains elusive. Heat stress can cause serious physiological dysfunction that may result in heat stroke, cardiac dysfunction and death, yet its impact on young poult health has not been investigated. The only recognized measures of comfort in young birds today are subjective, such as visual (i.e., poult distribution) and noise (i.e., excessive noise may indicate inadequate temperature) observations.

Hematologic parameters and the levels of certain plasma metabolites offer an objective measure and real-time insight into the physiological status of an animal. Some analytes change due to external stressors and health challenges before obvious behavioral or clinical signs are observed.

To investigate the effect of heat stress on blood parameters as an objective measure of poult comfort and its association with early poult mortality, the objectives of this project were to:

1) identify how temperature and relative humidity affect blood parameters of turkey poults.
2) investigate whether heat stress is associated with increased incidence of flip-over, dilated cardiomyopathy, higher mortality and overall poorer performance in turkey poults.

Four treatment groups were evaluated in the study, ranging from lowest temperature to highest temperature (T1, T2, T3 and T4). Maintaining temperatures and relative humidity within the target ranges was difficult due to the small variances in treatment group parameters. The brooding environmental temperature affected pH, partial carbon dioxide (pCO2), potassium (K) and sodium (Na) the most. The higher pH and lower pCO2 in treatments T3 and T4 were likely secondary to the poults' effort to cool down through panting. Na was significantly depressed while K was increased in the two treatments with higher brooding temperatures (T3 and T4). While researchers did not measure water intake in each room, they hypothesized that the lower concentration of Na in the blood was due to increased water intake. Upon completion of the experiment, more birds in T3 and T4 groups had distended crops compared to poults in groups T1 and T2, possibly due to increased water intake. The increase of plasma ketones at 3 days of age for poults in T3 and T4 suggests that these birds were consuming less feed and using more fat as their main fuel source.

Findings supported the hypothesis that heat stress can be associated with increased incidence of pendulous crop and decreased performance. Further, warmer brooding temperature may increase the incidence of dilated cardiomyopathy. There was not a significant difference in the concentration of creatinine kinase (CK) or cardiac troponin I (cTnI) between the groups. The results did not demonstrate that warmer brooding temperatures results in increased flip-overs. Low brooding temperatures were associated with higher mortalities during the first week of age.

Further research is needed to better understand the effect of environment on blood chemistry. This research revealed that blood analysis could assist with the evaluation of poult thermal comfort in an objective manner.

The research was made possible in part by an endowing Foundation gift from Prestage Farms.

Researcher Investigates Post-Harvest Methods to Reduce *Campylobacter* on Poultry Products

Dr. Jeremiah G. Johnson

Department of Microbiology, University of Tennessee, Knoxville, Tenn.

Campylobacter jejuni is a leading cause of bacterial-derived gastroenteritis in the United States, due to its ability to asymptomatically reside within the intestinal tracts of poultry. During processing, the bacterium can be released from birds and contaminate the meat where, despite the efforts of processors and grocers, it can survive and remain infectious for extended periods of time. Consumers may then be infected by *C. jejuni* after eating undercooked, contaminated food. The ability of *C. jejuni* to survive this process is surprising since the bacterium does not thrive under the conditions it encounters during processing and storage. In particular, *C. jejuni* is sensitive to atmospheric levels of oxygen with cell viability being reduced following even brief exposure. This observation led to the primary question of this research project: what bacterial factors does *C. jejuni* possess that allows it to survive processing and storage so that it can remain infectious to the consumer?

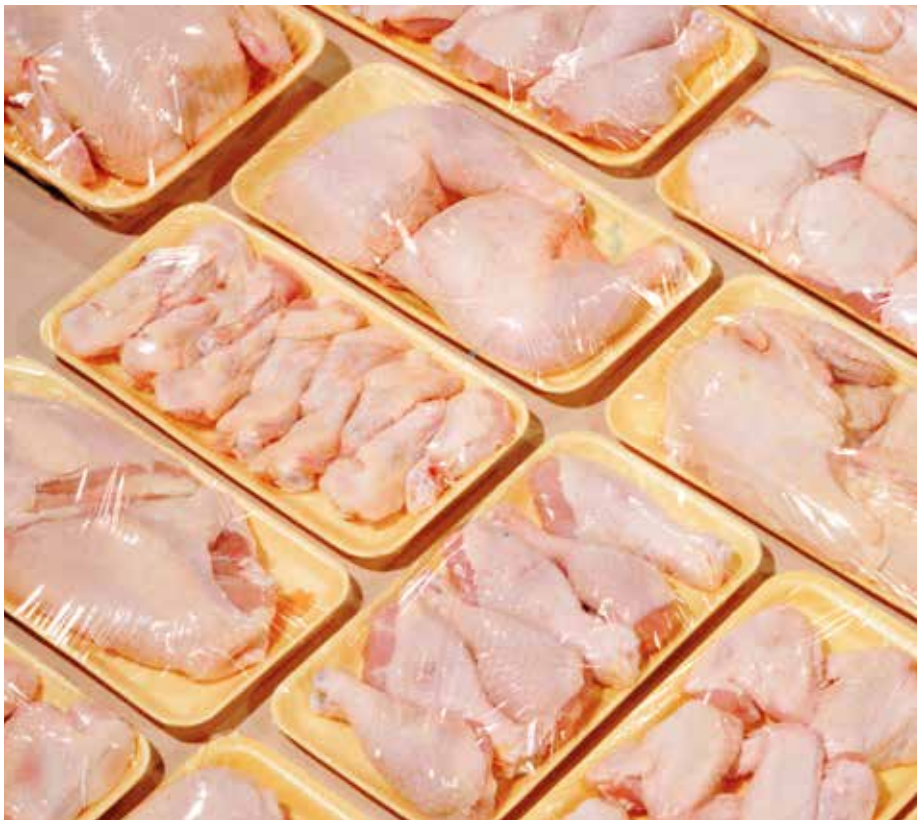
The original objectives for this study were to: (1) construct defined *C. jejuni* mutants and confirm they do not survive aerobic and/or refrigerated conditions; (2) examine for defined *C. jejuni* mutant survival on chicken meat stored under retail conditions; and (3) determine whether defined *C. jejuni* mutants colonize chickens as readily as the parental strain.

Researchers previously screened approximately 8,500 transposon mutants for their ability to survive up to two days under aerobic, refrigerated temperatures and quantitatively determined that 155 mutants exhibited <5% survival. Those mutants were prioritized based on the extent to which they were impacted, and the experiment was repeated three times. From that, it was determined 11 transposon mutants were reproducibly decreased for survival under aerobic, refrigerated conditions. For several of these mutants, the disrupted gene was identified using whole genome sequencing. Seven mutants were constructed of the different candidate genes and repeated the survival studies, finding that each reproducibility exhibited decreased survival when compared to the parental strain.

Retail chicken breast meat was purchased from a local grocer and divided it into one centimeter cubes and individually inoculated each with the seven *C. jejuni* mutants and the parental strain. The inoculated chicken cubes were stored for up to five days at aerobic, refrigerated temperatures and the number of viable bacteria was enumerated every day throughout the experiment on selective media. This experiment was conducted a minimum of three times for each of the mutants. Due to relatively high variability in survival among the seven strains on chicken meat, researchers were only able to determine that mutation of one specific gene significantly reduced aerobic, refrigerated survival.

White leghorn chickens were hatched in-house and inoculated with either the parental strain, the mutant strain or a combination of both strains at a 1:1 ratio on the day of hatch. These infected chicks were housed for seven days, euthanized and then their cecal contents were harvested. The number of viable *C. jejuni* within ceca of these birds was enumerated using selective media, which found that the specific mutant strain is unable to colonize the chicken cecum. This was supported by the observation that chicks infected with both strains ended up colonized with only parental.

The research was made possible in part by an endowing Foundation gift from Koch Foods.



Researcher Assesses the Use of Metals on the Resistance and Virulence of Avian Pathogenic *E. coli* (APEC)

Dr. Catherine M. Logue

College of Veterinary Medicine, Department of Population Health, University of Georgia, Athens, Ga.

Colibacillosis, as a result of *Escherichia coli (E. coli)*, is arguably one of the major causes of morbidity, mortality and carcass loss to the poultry production industry worldwide, putting at risk one of the cheapest and most valuable sources of protein. The causative agent of colibacillosis is avian pathogenic *E. coli,* or APEC. Disease associated with APEC is linked to several factors, including the health and welfare of the birds; quality of feed, water and litter; antimicrobial use and stewardship; and overall management practices. Despite approaches to control APEC on all these fronts, the disease is still prevalent and continues to rank as a top issue among poultry producers today. One of the challenges in combating colibacillosis is current limits on the use of antimicrobials to control disease. Consumers and processors are seeking a more "natural" product and producers are seeking alternatives to control disease outbreaks in light of FDA's's veterinary feed directive (VFD) and market pressure. One such approach that is gaining increased attention is metal supplements, which in themselves have been found to have desirable antimicrobial properties.

The primary hypothesis of this project was that metal supplementation can impact poultry health by selecting pathogenic *E. coli*, resulting in undesirable health outcomes for poultry production. The primary goal of the study was to assess the use of metals on resistance and virulence of APEC using both phenotype and genotype approaches. To achieve this goal several objectives were identified including: Screening collections of APEC for heavy metal associated resistance traits using phenotype and genotype analysis.

Sequencing selected strains to locate metal resistances and traits that accompany them. Performing data mining of sequenced APEC to locate and identify resistance traits characteristic of an APEC core.

Performing knockout analysis and measuring their effects on survival and selection of APEC strains in vitro and in vivo in the presence of metals.

Findings revealed that heavy metal resistance is prevalent in APEC, and some metals were of greater prevalence than others. The ability of strains to harbor heavy metal resistance traits was significant and was genetically linked to multiple systems. There is much still to learn about the role of agents, including heavy metals and their potential impact on the selection of APEC. The effect is complicated, particularly considering how many metal and resistance systems that APEC can harbor and how strains are able to adapt to the agents by means of multiple mechanisms. Different metal effects were evident from assorted studies.

The use of metals as potential antimicrobial agents and supplements will require much consideration in evaluating their potential benefits versus the risks which are likely to lead to the selection of some APEC strains. This work highlighted the need for a better understanding of specific supplements or metals in the greater context of their potential for selection or control for pathogens, such as APEC. Genomic data provides valuable evidence on APEC, including its virulence and resistance. Ongoing work with birds will determine the effects of supplements as a selective agent for APEC.

The research was made possible in part by an endowing Foundation gift from Mar-Jac Poultry.

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Researchers Evaluate the Effects of Variable Light Intensity Programs on Broiler Welfare

Dr. David Caldwell

Department of Poultry Science, University of Arkansas, Fayetteville, Ark.

Light intensity has been shown to affect the activity of birds, but most studies have focused on constant light intensities to determine their effect on welfare. This project provides objective measures to evaluate the impact on broiler welfare (i.e., lameness, stress and behavior) by light sources and intensity.

The three specific objectives for this study involved determining the effects of variable intensity lighting and a natural lighting program on behavior gait score and stress hormone corticosterone (CORT) compared to constant light intensity program in commercial broiler farm. Next, researchers investigated the effect of enrichment huts on broiler behavior, gait scores and stress in the different lighting programs of commercial farms. Lastly, the study evaluated central positive welfare indicators affected by various light intensities, natural lighting programs and enrichment hut treatments in commercial broiler farms.

Results of the first objective showed that the variable light (VL) intensity lighting program stimulated the dustbathing behavior and volunteer movement of birds. In addition, litter moisture content and footpad lesions were lowest in the VL intensity lighting program house. The number of culled birds in the VL treated house was significantly lower than 5 lux, 20 lux, and natural light (NL) birds on day 49. Total mortality was 25% lower in VL birds compared to NL birds. Average FCR (feed conversion ration) of VL birds was 2.2 % lower compared to 20 lux and NL birds.

The enrichment hut and VL intensity lighting program stimulated natural behavior and reduced the number of culled birds synergistically for the second objective. Results of brain welfare indicator gene expression signified that the high stress in 5 lux birds compared to 20 lux and VL birds. There was also chronic social defeat stress in NL birds compared to 5 lux, 20 lux, and VL birds.

Findings of this study shed light on the effects of variable light intensity lighting programs on commercial broilers, providing valuable new information on how lighting programs may improve broiler welfare and performance in commercial broiler farms. Long-range benefits will be the reduced production cost and the improved health of birds in the commercial broiler industry.

The research was made possible in part by an endowing Foundation gift from Simmons Foods.

Researcher Evaluates Competitive Inhibition of Pathogenic *Enterococcus cecorum*

Mitsu Suyemoto

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Pathogenic *Enterococcus cecorum (EC)* continues to plague the broiler industry, causing mortality from pericarditis and sepsis early in the growing period and lameness and paralysis late in the growing period. As gut colonization is a necessary first step in *EC* infection, it is an attractive target for intervention. If *EC* can be excluded from the gut, systemic *EC* infection could be greatly diminished. In this work we test the ability of recently generated, avirulent deletion mutants and commensal *EC* strains to disrupt gut colonization by pathogenic *EC*.

The objectives of the project were to: 1) test the efficacy of avirulent *EC* deletion mutants and commensal *EC* strains as probiotics to competitively inhibit the early colonization of the broiler gut with pathogenic *EC* and 2) test the safety and efficacy of the *EC* deletion mutants as potential modified-live in ovo vaccines to protect against pathogenic *EC*.

Using the *EC* commensal strains as an orally delivered probiotic, researchers found a significant decrease in the sepsis prevalence in broilers at 2 weeks post challenge with pathogenic *EC*. However, this difference did not persist for the 5-week duration of the study. The use of attenuated deletion mutants as probiotics did not disrupt long-term colonization of the gut by pathogenic *EC*, as no decrease in sepsis prevalence was seen at week 5 among treatment groups.

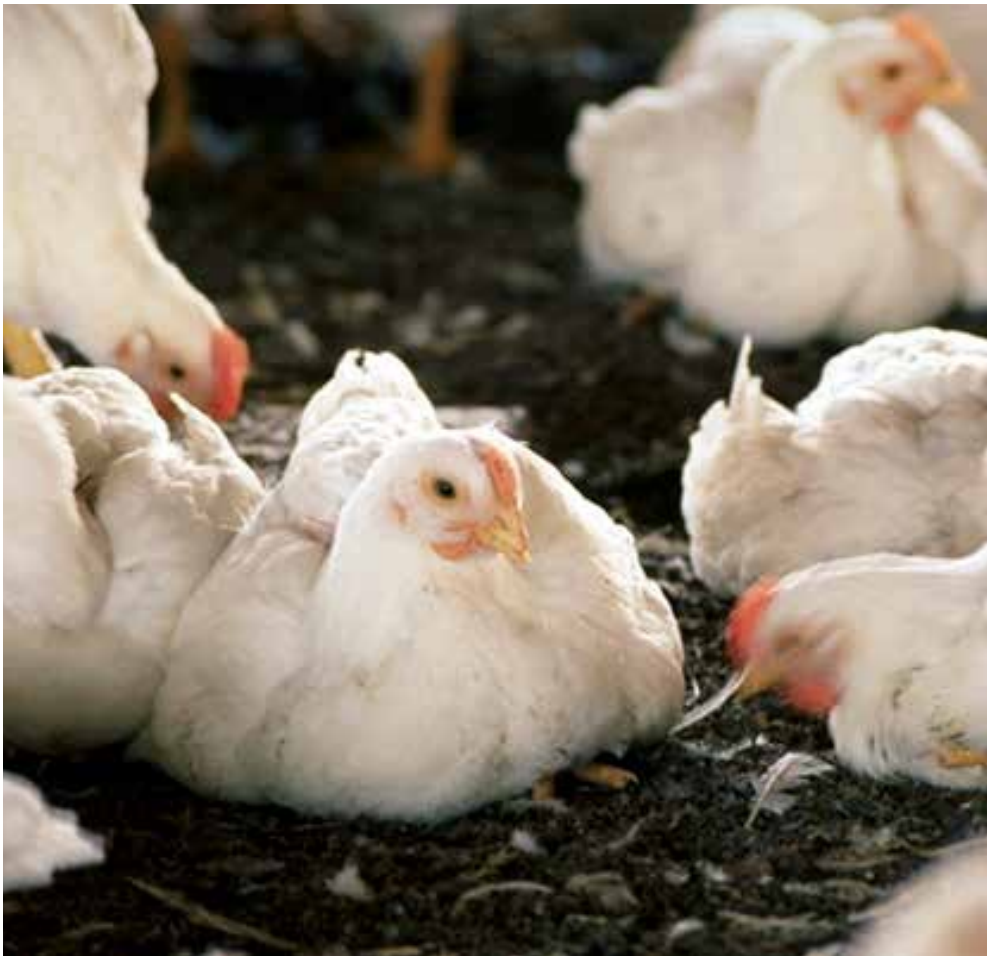
To mimic a natural infection more closely, researchers developed a new challenge protocol by decreasing the challenge dose 100-fold and only challenging a small number of birds per pen. These changes were made to expand the sensitivity of the challenge model in detecting the efficacy of interventions designed to decrease pathogenic *EC* morbidity and mortality.

When tested as in ovo vaccines, neither the commensals nor the deletion mutants were effective in decreasing sepsis in the early life period, with no decrease in sepsis found among the treatment groups. In addition, safety concerns were raised with the use of the deletion mutants with one reverting to a virulent phenotype even though it was repeatedly shown to be completely avirulent in both the embryo lethality assay and bird challenge model.

This study found that oral inoculation of newly hatched chicks with commensal *EC* significantly decreased the sepsis prevalence at 2 weeks post challenge. Further investigation is needed to see if this effect could be extended for longer in the grow-out period, possibly through continuous feeding or water delivery.

Changes to *EC* challenge models should be considered in future work and may enable the discovery of successful interventions to decrease the morbidity and mortality of pathogenic *EC* infection. Additionally, caution should be used when testing even attenuated deletion mutants of *EC* as modified-live vaccines as reversion to virulence is possible.

The research was made possible in part by an endowing Foundation gift from Wayne-Sanderson Farms.



Researchers Identify Early Indicators of Necrotic enteritis Disease in Broiler Chickens

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In this age of 'no antibiotic ever' farming, the re-emerging Necrotic enteritis (NE) disease caused by Clostridium perfringens poses a major economically important health concern in poultry, particularly in broiler flocks. Identifying biological indicators, such as a specific class of volatile organic compounds (VOC), during NE development may help initiate prompt disease control measures. In this study, researchers aimed to identify NE-specific VOC, including reduced sulfur compounds (RSC) in the feces/manure as well as environmental (i.e., air) samples collected during the 4 day-period of NE development using an experimental infection model in broiler chickens.

The project consisted of three objectives. The first objective was to reproduce NE in broiler chickens using an experimental C. perfringens challenge model. The second objective was to evaluate changes in the composition of VOC/ RSC during the early and late stages of NE disease progression in birds using gas chromatography-mass spectrometry (GC-MS) and identify VOC/ RSC patterns associated with NE. The last objective was to validate GC-MS method development findings with portable or handheld air-analysis device(s).

To reproduce NE experimentally in broiler chickens, researchers sought to use a dysbiosis-based NE model development that did not include the use of coccidia infection for NE predisposition. Seven field strains of C. perfringens were usedto infect birds to evaluate their relative disease-producing abilities. Results showed that two of the strains were found to be highly pathogenic to broilers and the gross and histopathology lesions were characteristic of clinical NE.

A total of four animal experiments/ trials were conducted to identify NE-specific VOC during disease development, and the manure and air samples were collected and analyzed by GC-MS. The data indicated that certain amines emitted from the manure correlated with the incidence of NE. Also investigated was the effect of litter acidification on NE development in comparison to non-acidified litter control group and thereby, any effect of treated litter on VOC emission. Results showed that there was no statistically significant difference in NE lesions between the two treatment groups. However, manure samples collected from NE-impacted birds exhibited higher concentrations of two amines when compared to those collected from uninfected control birds.

Extensive testing of a hand-held analyzer to determine RSC emitted from samples collected from infected and uninfected birds proved to be inconclusive, and both sample types had very low levels of reduced sulfur concentrations.

Collectively, the findings showed that: 1) It is possible to reproduce NE in broiler chickens, 2) Two specific amine VOCs appear to be positively correlated with the incidence of NE in broiler chickens and that further work is required to validate these findings under commercial farm setting, and 3) Upon validation, calibrating a low-cost, portable GC may provide an avenue for screening for this disease in the field.

Although further validation is required to extend findings to future field applications, the two VOC (amines) may serve as indicators of NE screening in flocks, and thus could aid in early NE detection. Furthermore, findings can be applied to the development of a method suitable for identifying rapid and reliable NE detection precision tech-tools.

The research was made possible in part by an endowing Foundation gift from Case Farms.

Researchers Assess Dry Hydrogen Peroxide as a Replacement for Formaldehyde in Commercial Poultry Hatcheries

Dr. Brian J. Jordan

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Hatchery sanitation is a continual issue in commercial poultry and has become a focus since the removal of antibiotics in production. Poor sanitation leads to reduced hatchability, increased 3- and 7-day mortality, and chronic infections that can reduce performance. More than 30 years ago, using a formaldehyde fogging system in hatchers was a common practice to control microbes. But as the undesirable effects on equipment, chick respiratory quality and hatchery workers were realized, the practice was discontinued in many places. Now, with reduction in antibiotic use, formaldehyde fogging has again become a common practice.

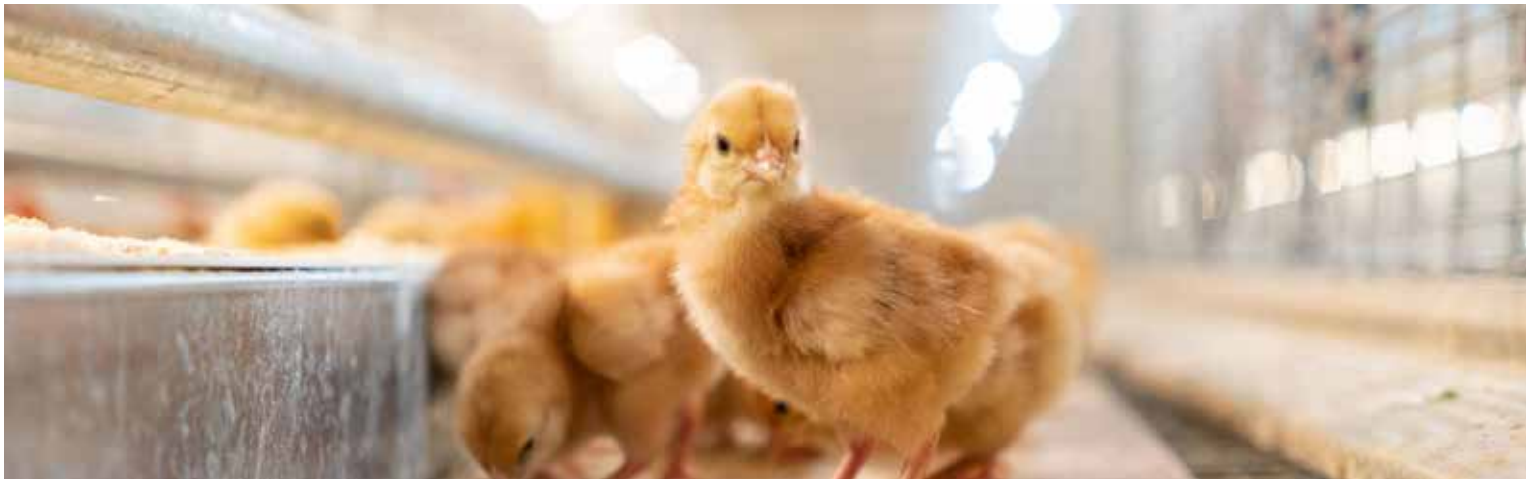
Dry hydrogen peroxide (DHP) is a proprietary technology that produces a true gas-phase hydrogen peroxide molecule, making it different than the common liquid peroxide solutions normally used in sanitation and medicine. In previous research, using DHP in common spaces of the hatchery resulted in increased hatch of fertile, decreased aspergillus positive chicks and decreased 3-day mortality at the farm. Other research has shown that using DHP in a concentrated manner in single-stage incubators can achieve the same level of microbial reduction on eggshells as pre-fogging eggs with formaldehyde prior to set. With these data, the next logical step would be to test DHP against formaldehyde fogging in hatchers, as is done in the U.S. industry.

The goal of this project was to compare the efficacy of using DHP in a commercial hatchery to formaldehyde. The central hypothesis of this research was that using DHP in the egg room of the hatchery, the hatchery common spaces and in the incubators and hatchers themselves, in a cumulative manner, would result in microbial control and hatchery and production performance equal to the use of formaldehyde fogging.

DHP machines were installed in the common spaces of a commercial broiler hatchery and in select single-stage incubators and hatchers. Data was collected for 12 months comparing hatchability, residue breakouts, fluff counts, microbial loads on surfaces and eggshells, and 3-day mortality and necropsy evaluation of the 3-day mortality between the groups of eggs that were treated with DHP or treated with the standard formaldehyde fogging program. Overall, no differences were seen between treatments in fluff counts, residue breakouts or general hatchery surface microbial load, though significant differences were seen on surface microbial loads in the hatchery egg cooler after the introduction of DHP. A significant reduction in eggshell microbial load was seen on groups of eggs treated with DHP during incubation compared to eggs that were not, though there was a large natural decline in both groups compared to before set. There was a significant increase in hatchability in the groups treated with DHP compared to those same machines prior to DHP addition (3.11%), and DHP treatment brought the hatch of those machines up to a level that was not significantly different than the formaldehyde program (85.88% and 86.1%, respectively). There was no difference between treatments in 3-day mortality or the post-mortem analysis of that mortality between treatments.

The results of this trial demonstrate that DHP, in the single-stage system utilized, performed as well as the industry standard formaldehyde fogging program. This is significant for the poultry industry, as it shows that there is a viable alternative for formaldehyde use, especially since formaldehyde has already been banned in some states and is currently under risk evaluation with the Environmental Protection Agency, which could lead to a total ban.

The research was made possible in part by an endowing Foundation gift from Fieldale Farms.



Researchers Address Early Incubation Temperature Effects on the Development of Wooden Breast in Broilers

Dr. Jessica D. Starkey

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Multi-stage egg incubation systems are challenging to manage and attempts to keep late-stage embryos from overheating create situations where early-stage embryos are at sub-optimal temperatures during the period when skeletal muscle fiber number and satellite (muscle stem) cell populations are being established (embryonic day (ED) 4 to 11). There is little published evidence regarding the impact of variation in early-stage (ED 4 to 11) incubation temperature on modern broiler embryonic skeletal muscle development and post-hatch muscle growth characteristics, feed efficiency, meat yield or incidence of myopathies in modern commercial broilers. The project objectives were established to provide information currently unavailable in the scientific literature for use by industry professionals in optimizing incubation methods and operational parameters to maximize hatchability, chick quality, growth performance and meat yield, as well as to determine the impact on the incidence and severity of the breast meat quality defects, wooden breast and white striping, in modern commercial broiler chickens.

The project objectives were to determine the impact of early-stage (embryonic day (ED) 4 to 11) incubator temperature variation (36.1°C = COLD vs. 37.1°C = Control (CTL) vs. 38.6°C = HOT) on commercial broiler chicken growth performance and feed efficiency, carcass and breast meat yield, and the incidence and severity of meat quality defects, such as wooden breast and white striping, as well as skeletal muscle developmental characteristics, satellite cell (SC; muscle stem cell) mitotic (proliferative) activity, and muscle growth characteristics at multiple time points over the rearing period.

Hatch Characteristics: Early-stage incubation temperature treatments did not alter embryonic mortality (early, middle, late and total dead; pipped; malpositioned), egg weight loss during incubation, nor the proportion of male and female chicks at hatch. Hatch of fertile tended to be lower in eggs incubated in both the COLD and HOT incubators compared with those in the CTL incubators. Since chicks were removed from the hatchers simultaneously to facilitate vent sexing. As expected, chicks hatched from the COLD treatment incubators were heaviest at hatch, while those from the HOT treatment were 10% lighter. The CTL chicks were intermediate.

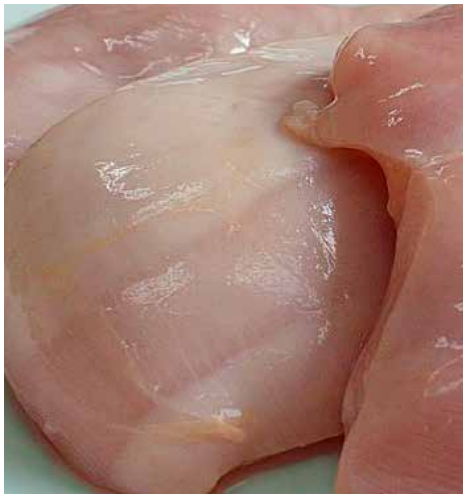
Growth Performance: Incubating broiler hatching eggs at air temperatures of 36.1°C (COLD) during early-stage incubation (ED 4 to 11) negatively impacted broiler day 0 to 32 body weight gain and final body weight compared with the CTL (37.1°C) treatment. Incubating eggs at 38.6°C (HOT) during early-stage incubation resulted in similar performance metrics when compared with those incubated at the CTL temperature of 37.1°C from ED 4 to 11.

Carcass Characteristics: Incubating broiler hatching eggs at 36.4°C (COLD) during early-stage incubation (ED 4 to 11) negatively impacted breast, wing, thigh and drum chilled parts weights and breast yield compared with those incubated at the CTL (37.5°C) temperature. Birds from the COLD incubators tended to have a 25-g reduction in breast weight (412 vs. 438 and 443 g) that resulted in a 6% decrease in breast meat yield compared with those from CON and HOT incubators. Incubating eggs at 38.6°C (HOT) during early-stage incubation resulted in reductions in wing and drum chilled parts weights but did not impact breast, tender and thigh weights compared with birds from the CTL incubators. Altering early-stage incubation temperature did not impact the incidence nor severity of wooden breast or white striping meat quality defects in broilers reared to 32 days-of-age.

Satellite Cell Activity and Muscle Growth Characteristics: Altering the early-stage incubation temperature from ED 4 to 11 did not influence the proliferative activity or myogenic regulatory factor expression profiles of breast muscle satellite cells on day 7, 14, 21 or 28 post-hatch. However, the cross-sectional area of breast muscle fibers of birds from the CTL and HOT incubation treatments was larger on both day 7 and 21 post-hatch compared with those from the COLD incubators. These results help explain the 6% lower breast meat yield observed in birds from the COLD vs. HOT and CTL treatments.

Overall, the results of this project highlight the importance of careful hatching egg incubator management. These results indicate that the cost of incubating broiler hatching eggs at sub-optimal temperatures (36.4°) during early-stage incubation can be as much as 25 grams per bird, which if breast meat is worth $0.438 per gram [USDA 3-year average 199 cents per pound (range 150 to 248)], that is an estimated $7.1 million dollars per year in a typical 1.25-million-broilers-per-week integrated commercial broiler complex or $854.7 million dollars per year for the U.S. broiler industry as a whole.

The research was made possible in part by an endowing Foundation gift from Koch Foods.



Researchers Assess Using an Electrostatic Precipitator to Improve Indoor Air Quality in Cage-Free Layer Houses

Dr. Sanjay Shah

Biological and Agricultural Engineering Department, North Carolina State University, Raleigh, N.C.

Compared with cage systems, cage-free egg layer systems improve bird welfare. However, greater bird activity in cage-free layer houses (CFLH) can degrade indoor air quality, which could affect performance and welfare of both the birds as well as the workers since they spend more time inside CFLHs picking up floor eggs vs. caged layer houses. A recirculating electrostatic precipitator (ESP) could reduce dust concentrations and thermal stratification in winter when ventilation rates are low and dust concentrations are higher.

The overall objective of this project was to develop and evaluate a recirculating ESP for its ability to improve indoor air quality in a CFLH with litter floors. Specific objectives were to design and fabricate a full-scale recirculating ESP unit; evaluate the removal efficiency of the ESP in the cage-free layer house for particulate matter, ammonia, and airborne bacteria and fungi, and; evaluate the impact of the ESP on barn indoor air quality for particulate matter. In the CFLH, the ESP was moderately effective (53% removal efficiency) in trapping total suspended particulates (TSP) when the fan was off and dust concentrations were very high. Its effectiveness in trapping particulate matter smaller than 10 microns (PM10) and particulate matter smaller than 2.5 microns (PM2.5) were lower, 28% and 22%, respectively. With the fan operating intermittently or continuously, PM10 removal rates were lower than TSP while PM2.5 removal was negligible. With all the fans operating in a teaching barn, PM10 and PM2.5 removal were modest (36%) and low (8%), respectively. The ESP trapped >50% of the total bacteria but fungi concentrations were too low to calculate removal efficiency. The ESP did not remove ammonia and its impact on volatile organic compounds was unclear.

The teaching barn and cage-free layer house had very high dust levels. With all fans operating, PM10 concentrations upstream of the ESP in the teaching barn averaged nearly 1,200 mg/m3 while the ESP reduced downstream concentrations by 40%. In the CFLH, with the fan off, TSP levels 11.6 m downstream of the ESP was >18,000 mg/m3 while TSP levels at the same distance upstream were < 4,500 mg/m3 though the ESP likely did not have an impact. Ventilation reduced TSP, PM10, and PM2.5 concentrations though PM10 concentrations were lower than TSP, and PM2.5 concentrations were the lowest. The ESP did not affect microbial air quality. Higher airflow rate, ultraviolet-C wattage, and air current could improve indoor air quality.

In conclusion, timer operated minimum ventilation fans lead to very high dust concentrations in CFLHs and should be replaced with variable speed fans. Further dust mitigation methods should be considered. A redesign of the ESP proposed here could lead to much improved dust and airborne bacteria removal.

The research was made possible in part by an endowing Foundation gift from Cal-Maine Foods.

Researchers Evaluate Treatment Methods to Prevent Colonization of Pathogenic Bacteria in the Hatchery

Dr. Christine N. Vuong and Dr. Daneille Graham

Poultry Science Department, University of Arkansas - Division of Agriculture, Fayetteville, Ark.

Horizontal transmission of opportunistic bacterial and fungal pathogens during hatch can have detrimental effects on early chick performance, particularly as initial colonizers. To prevent colonization by pathogenic organisms, beneficial non-pathogenic bacteria must be established in the gut to inhibit growth of undesirable microbes. Although formaldehyde fumigation does control total environmental microbial counts, this treatment does not differentiate between beneficial or pathogenic microbes, still providing opportunity for pathogenic bacteria to colonize the gut. There are no published laboratory challenge models adequate for testing products to control the microbial bloom in the hatch cabinet and promote colonization by beneficial microbes in neonatal chicks. Without an appropriate challenge model, it would be impossible to capture how a specific product will compare to formaldehyde fumigation without conducting experiments in commercial hatch cabinets. Thus, researchers developed a model containing multiple hatchery-associated pathogens to simulate the environmental contamination that occurs in commercial hatch cabinets during the hatching phase to evaluate formaldehyde fumigation alternatives, such as probiotics, and the effects on neonatal pioneer colonization. The objectives of this research were:

Objective 1: Multi-pathogen hatcher "bloom" challenge model development using multi-species field samples collected from commercial hatchers.

Objective 2.1: Evaluation of the effects of a spray-applied probiotic as an alternative to formaldehyde fumigation, utilizing the newly developed multi-pathogen challenge model.

Objective 2.2: In ovo application of Bifidobacterium spp. and lactic acid bacteria to prevent colonization by pathogenic microbes during hatch, utilizing the newly developed multi-pathogen challenge model.

The pathogen mix challenge model developed in Objective 1 was used to evaluate alternatives to formaldehyde fumigation in Objectives 2.1 and 2.2. In Objective 2.1, spray-application of Bacillus amyloliqufaciens solid state fermentation products into the hatch cabinet altered the composition of the microbial bloom and shifted enteric colonization at hatch, but no differences in performance were observed. In Objective 2.2, in ovo administration of select combinations of lactic acid bacteria and/or bifidobacteria into the amnion at DOE18 reduced enteric colonization by gram-negative bacteria and Enterococcus spp. and positively impacted 14-day performance in broiler chickens.

Overall, the pathogen mix challenge model developed can be used by investigators to assess alternatives to formaldehyde fumigation in a laboratory setting prior to evaluation on a commercial scale. Additionally, these results suggest that beneficial microorganisms applied during late embryogenesis either into the hatch cabinet environment or by in ovo injection into the amnion can promote colonization by beneficial microorganisms and may improve performance. However, a multifaceted approach that exposes chicks to beneficial microorganisms prior to and during hatch will likely be necessary as a long-term solution to replace formaldehyde fumigation, and the pathogen mix model can be employed to validate commercially applicable approaches of interest moving forward.

The research was made possible in part by an endowing Foundation gift from George's Inc.

Additional Research Information Available on Our Website, uspoultry.org/research

Dr. Darrin Karcher Presented USPOULTRY Dr. Charles Beard Research Excellence Award

USPOULTRY and the USPOULTRY Foundation are pleased to recognize Dr. Darrin Karcher as the recipient of the annual Dr. Charles Beard Research Excellence Award. Dr. Karcher is an associate professor of animal sciences at Purdue University in West Lafayette, Indiana, and an adjunct associate professor of animal sciences at Michigan State University in East Lansing, Michigan. The award is named in honor of Dr. Charles Beard, former director of the Southeast Poultry Research Laboratory and former vice president of research at USPOULTRY.

The USPOULTRY Foundation Research Advisory Committee (FRAC) selected Dr. Karcher for this award due to his exceptional research focused on nutrition, management and skeletal issues in commercial layers. He has been the principal investigator for five USPOULTRY funded projects and has been a co-investigator on two additional USPOULTRY projects.

"Dr. Karcher was a standout nominee for this award because his research, focusing on addressing producers' concerns with laying hen management, bird welfare and food safety, has provided a wealth of knowledge for the layer industry and has led to many technological advancements in those areas," noted Dr. Denise Heard, vice president of research programs, USPOULTRY.

Dr. Karcher has developed an extension program that improves poultry production, regardless of scale, and is grounded in science. Dr. Karcher completed his B.S. from The Ohio State University, M.S. in Animal Science at the University of Wisconsin, Madison, and his Ph.D. in Animal Science at Purdue University. He serves on the board of directors for the National Egg Quality School, Poultry Health Management School and Midwest Poultry Federation. He has also served on the board of directors of the World's Poultry Science Association. He was a Societal Impact Fellow at Purdue University and the North Central Region's Excellence in Extension Award winner at Purdue University. In addition, Dr. Karcher is the recipient of many awards and fellowships and has published numerous peer-reviewed papers and authored publications, including book chapters.

The goal of the Dr. Charles Beard Research Excellence Award is to recognize outstanding completed research projects, funded by USPOULTRY or the USPOULTRY Foundation, which have made a significant positive impact on the poultry industry. As the recipient of the award, Karcher received a $1,500 cash prize. The award was presented to him during the USPOULTRY Chair's Reception at the International Production & Processing Expo (IPPE) by Bill Griffith, treasurer for the USPOULTRY board of directors and long-standing FRAC member.

Dr. Darrin Karcher (right), receiving the Dr. Charles Beard Research Excellence Award from Bill Griffith.