USPOULTRY and Foundation Approve $815,000 in New Research Grants through the Comprehensive Research Program
Board Research Initiative Projects Total $250,000
USPOULTRY Announced the Release of a First-Ever Report of Antimicrobial Use Across U.S. Broiler Chickens and Turkeys
Researchers Study Effectiveness of Heat Treatment of Poultry Houses
Additional Research Needed to Determine Peracetic Acid Exposure in Poultry Plants
Research Points to New Methods for Poultry Wastewater Treatment
Research Provides New Understanding of ILT Vaccines
Research Shows Practical Method to Reduce Litter Moisture
Research Provides Insight on Colonization of Broilers by Salmonella
Researchers Use Laser for Broiler House Enrichment
Research Provides Enhanced Safety of Poultry Products
Research Provides New Method to Detect Woody Breast Fillets
Research Provides Insight on How to Improve Indoor Air Quality in Poultry Housing with Black UV Light
Research Provides Alternatives to Maceration of Day of Hatch Male Layer Chicks
Research Examines Alternative Feeding Programs and Photostimulation Periods for Broiler Breeders
Research Assesses PAA in Poultry Processing Wastewater Treatment Systems
Dr. Kenneth Anderson Receives 2019 Charles Beard Research Excellence Award
USPOULTRY and Foundation Approve $815,000 in New Research Grants through Comprehensive Research Program

USPOULTRY and the USPOULTRY Foundation approved approximately $815,000 for 12 new research grants at eight 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 committee 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 research grants for each institution include:

- **Foreign Animal Disease Outbreak**
  North Carolina State University (research grant made possible in part by an endowing Foundation gift from Case Farms)

- **Cage-Free Pullet Density: Production and Welfare Outcomes**
  Purdue University (research grant made possible in part by an endowing Foundation gift from CCF Brands)

- **Feed Additive for Reducing Incidence of Wooden Breast Disease in Commercial Broiler Chickens**
  University of Delaware (research grant made possible in part by an endowing Foundation gift from Mountaire Farms)

- **Evaluating the Impact of Ventilation Shutdown for Depopulation of Broiler Breeders during a Foreign Animal Disease Outbreak**
  North Carolina State University (research grant made possible in part by an endowing Foundation gift from Claxton Poultry)

- **Its Relation to Manifestation of Lameness, Ascites and Woody Breast Condition**
  North Carolina State University (research grant made possible in part by an endowing Foundation gift from Wayne Farms)

- **Genetic Identification and Screening for Potent Anti-Salmonella Gut Peptide Variant in Chicken: Avian Defensin, Beta Defensin 1 (AvBD1)**
  The Ohio State University (research grant made possible in part by an endowing Foundation gift from Simmons Foods)

- **Fate and Effect of Commercial Peracetic Acid Solutions in Poultry Processing Waste Water Biological Treatment Processes**
  Georgia Tech Research Institute (research grant made possible in part by an endowing Foundation gift from the Stanley & Dorothy Frank Family Foundation)

- **Effect of Protease Enzyme on Corn and Soybean Meal-Based Laying Hen Diet to Reduce Feed Cost, Improve Egg Quality and Egg Solids in Post-Peak and Late Lay**
  Mississippi State University (research grant made possible in part by an endowing Foundation gift from Cal-Maine Foods)

- **Evaluation of a Drinker System with or without Trays on House Litter Conditions, Bird Performance, Health and Welfare**
  University of Georgia (research grant made possible in part by an endowing Foundation gift from Claxton Poultry)

- **Longitudinal Assessment of Skeletal and Cardiac Structures in Broilers Reared Under Slow Versus Fast Growth Rate Regimen and Its Relation to Manifestation of Lameness, Ascites and Woody Breast Condition**
  North Carolina State University (research grant made possible in part by an endowing Foundation gift from Claxton Poultry)

- **Genetic Identification and Screening for Potent Anti-Salmonella Gut Peptide Variant in Chicken: Avian Defensin, Beta Defensin 1 (AvBD1)**
  The Ohio State University (research grant made possible in part by an endowing Foundation gift from Simmons Foods)

- **Fate and Effect of Peracetic Acid Solutions in Poultry Processing Biological Nitrogen Removal and Anaerobic Treatment Processes**
  Georgia Institute of Technology (research grant made possible in part by an endowing Foundation gift from Sanderson Farms)

- **Profiling Salmonella Serotypes Through Processing**
  University of Georgia (research grant made possible in part by an endowing Foundation gift from Fieldale Farms)

- **Whole Genome Sequencing and Molecular Analysis of Infectious Bronchitis Virus DMV1639 Strains Circulating in the Field**
  University of Connecticut (research grant made possible in part by an endowing Foundation gift from Koch Foods)

USPOULTRY and Foundation Approve $250,000 in New Board Research Initiative Grants

USPOULTRY and the USPOULTRY Foundation approved approximately $250,000 in funding for two new research grants at two institutions through the Board Research Initiative program. The research funding was approved by the boards of directors of both organizations, based on recommendations from the Foundation Research Advisory Committee.

The research was made possible in part by donations to the USPOULTRY Foundation. The donations were 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.

The research grants for each institution include:

- **Evaluation of Welfare, Behavior and Health as Affected by Growth Rate of Broiler Chickens**
  Mississippi State University (research grant made possible in part by an endowing Foundation gift from Pilgrim’s)

- **Investigation into the Cause and Prevention of False Layer Syndrome**
  University of Georgia (research grant made possible in part by an endowing Foundation gift from Cargill)
USPOULTRY Announced the Release of a
First-Ever Report of Antimicrobial Use Across
U.S. Broiler Chickens and Turkeys

USPOULTRY announced the release of the U.S. poultry industry’s first-ever report quantifying antimicrobial use on broiler chicken and turkey farms. The report shows dramatic reductions of turkey and broiler chicken antimicrobial use over a five-year timeframe. As part of its commitment to the transparency and sustainability of a safe food supply, the poultry industry aims to strike a balance between keeping poultry flocks healthy and the responsible use of antimicrobials, especially those medically important to human health.

Under the research direction of Dr. Randall Singer, DVM, PhD, of Mindwalk Consulting Group, LLC, the report represents a five-year set of data collected from 2013 to 2017 regarding the use of antimicrobials in U.S. broiler chickens and turkeys throughout their lifetime, from hatchery to day of harvest. It was prepared through a systematic collection of on-farm antimicrobial use data to capture the disease indications and routes of administration through which antimicrobials were given to the poultry.

Given several key differences among broiler chickens and turkeys – namely differences in weight, life span, susceptibility to lifetime illness and the number of effective medical therapies available – the data from broiler chickens and turkeys should neither be combined nor compared.

Key changes among broiler chickens over the five-year period show:
- Broiler chickens receiving antimicrobials in the hatchery decreased from 93% to 17%
- Hatchery gentamicin use decreased approximately 74%
- Medically important in-feed antimicrobial use in broiler chickens decreased by as much as 95%. For example: tetracycline 95%, virginiamycin 60%
- Medically important water-soluble antimicrobial use in broiler chickens decreased by as much as 72%. For example: penicillin 21%, tetracycline 47%, sulfonamide 72%
- There was a documented shift to the use of antimicrobial drugs that are not considered medically important to humans (e.g., avilamycin and bacitracin BMD)

Key changes among turkeys over the five-year period show:
- Turkeys receiving antimicrobials in the hatchery decreased from 96% to 41%
- Hatchery gentamicin use decreased approximately 42%
- Medically important in-feed antimicrobial use in turkeys decreased: tetracycline 67%
- Medically important water-soluble antimicrobial use decreased substantially. For example: penicillin 42%, tetracycline 28%, lincomycin 46%, neomycin 49%, erythromycin 65%

Antimicrobial use among broiler chickens and turkeys decreased dramatically between 2013 and 2017, and there are a couple of key explanations for this:
- Changes in FDA regulations, which were fully implemented in January 2017, effectively eliminated the use of medically important antimicrobials for production purposes and placed all medically important antimicrobials administered in the feed or water of poultry under veterinary supervision
- A continued focus by poultry companies on disease prevention, thereby reducing the need for antimicrobials
- Improved record-keeping of all antimicrobial administrations, which is a key component of antimicrobial stewardship

Furthermore, the broiler chicken and turkey industries have increased the production of animals raised without antimicrobials. Participation in this effort was entirely voluntary. The poultry industry recognized the importance of this work and responded. The 2017 data in this report represent more than 7.5 billion chickens (about 90% of annual U.S. chicken production by the major companies on the WATT PoultryUSA list) and 160 million turkeys (about 80% of annual U.S. turkey production by the major companies on the WATT PoultryUSA list).

Retired USPOULTRY Vice President of Research, Dr. John Glisson, DVM, MAM, Ph.D., affirmed, “This research is the first step in determining how antimicrobials are used in the entire poultry production system of the U.S., and to succeed, we need participation from the majority of companies. We couldn’t be more pleased with the response of the poultry industry.” Glisson cautioned, though, that there are still serious bird illnesses (e.g., necrotic enteritis, gangrenous dermatitis and colibacillosis) for which the poultry industry has few effective interventions. And when birds get sick from these diseases, they must receive therapy. He confirmed that “driving good antimicrobial stewardship in poultry, as opposed to simple documentation of reduced use, is our end goal for the best outcomes for both the people and the poultry.”

Moving forward, Dr. Singer will continue the annual collection of data from the broiler chicken and turkey industries and will begin collecting data from the U.S. table egg industry. It is anticipated that this new data will provide greater clarity about antimicrobial use in individual flocks.
Researchers Study Effectiveness of Heat Treatment of Poultry Houses

Dr. Eric Benson
University of Delaware, Newark, Delaware

Management and control of fast-moving poultry diseases such as highly pathogenic avian influenza (HPAI) requires a combination of steps including biosecurity, surveillance, quarantine, depopulation, disposal, and cleaning and disinfection. Because of the difficulties associated with cleaning and disinfection, an alternative heat treatment program was used during the spring-summer 2015 HPAI outbreak. In this response, facilities were dry cleaned to remove gross organic matter. High risk areas were cleaned to less than 6 mm (0.25 inch) of organic material and low risk areas were allowed up to 12 mm (0.5 inch) of organic matter. Facilities were then heated for seven days, with the temperature reaching to 37 to 48° C (100 to 120° F) for three continuous days. This heat treatment process needed to be evaluated to determine how effective the method is at inactivating virus and bacteria within various depths of organic material. The depth profiles used in this study were: surface, 6 mm (0.25 inch), 2.5 cm (1 inch) and 10 cm (4 inches) of litter to more accurately reflect depths of litter left after the initial dry cleaning.

This project involved evaluation and comparison of heat treatment versus wet cleaning with chemical disinfection under field conditions. For biosecurity reasons, a LaSota vaccine strain of Newcastle Disease Virus (NDV) and a mixture of Salmonella serovars were used as surrogates for HPAI virus and other bacteria. Screened and dried used poultry litter was used as a source of consistent organic matter. The project was split into three objectives. For objective A the most appropriate temperature, time and humidity profiles along with the maximum depth of organic matter that can be effectively heat treated were determined. In objective B, NDV and Salmonella were inoculated onto steel sample platforms and treated in the laboratory with the levels of organic matter and heat profiles determined in objective A. In objective C, the procedures evaluated in objectives A and B were evaluated under field conditions.

Maintaining the required temperature profile throughout the poultry house was found to be critical. In testing during colder months, samples at 10 cm (4 inches) did not reach the required temperature of 100° F. This observation further supports the recommendation that houses must be well sealed and adequate heat sources utilized when heat treating during cold weather.

However, the temperature results do validate that thinner layers (2.5 cm or less) of organic matter are acceptable. If heat treatment is performed after carcass and litter disposal, litter depth should not be a concern since a large portion of the organic matter will have been removed. If heat treatment is performed prior to carcass and litter disposal, litter should be treated as contaminated during disposal since pathogens in the litter will likely not be inactivated.

Based on the results of this study, the heat treatment protocol developed by USDA is effective for the reduction of microorganisms in litter; specifically, NDV and Salmonella. Caution should be used to ensure that almost all organic material is removed from the facility before heat treatment since it was found that, under field conditions in cold weather, as little as four inches of litter could harbor viable pathogens after heat treatment.
Additional Research Needed to Determine Peracetic Acid Exposure in Poultry Plants

Jenny Houlroyd

Occupational Safety and Health Programs Office, Georgia Tech Applied Research Corporation, Atlanta, Georgia

Jenny Houlroyd and researchers at Georgia Tech’s Enterprise Innovation Institute recently completed a research project intended to increase industry knowledge of exposure to peracetic acid (PAA) by comparing four currently commercially available exposure monitoring methods and exploring if distance from a source of PAA changed airborne concentrations. The methods selected for use in this study had to be those that were readily accessible for a plant safety and health manager or USDA personnel to utilize for exposure assessment. There are currently no other (published) studies examining the three selected electrochemical PAA sensors with the traditional chemistry method. Data-logged results were then compared to air samples for PAA, which were collected using SKC Non-agency method 57 (based on the Hecht, et. al 2004 method).

The findings from the evaluation completed at three different poultry processing facilities indicate there is considerable variation and lack of precision between the methods tested. This lack of reliability was observed both between the measurement methods and within the individual measurement methods.

The lack of reliability of the sampling methods indicates a need for additional research into a more stable, robust analytical method that is capable of producing consistent results. Poultry processing facilities are challenging environments for testing due to the number of potentially confounding variables present, including temperature, relative humidity, etc.

Overall, based on the lack of consistency, precision, and potentially accuracy of the four tested sampling methods, caution should be exercised when interpreting the results of any single method at this time.

“This is a perfect example of research funds being rapidly deployed by USPOULTRY and the Foundation to help address an industry critical concern. Like most research, it’s one more ‘brick in the wall’ that will assist our industry with continuous improvement in providing sustainable and wholesome products,” said John Starkey, president of USPOULTRY.
Dr. Gibum Kwon

University of Kansas, Lawrence, Kansas

Poultry processing facilities use a large volume of fresh water and produce a large volume of wastewater daily. Current poultry wastewater remediation technologies include a series of consecutive steps including sedimentation, biological oxidation of organic pollutants using microorganisms, and filtration. These processes may require using chemical agents and biological species that must be removed before discharge or may require a long treatment time resulting in the increase of operating cost. The primary goal of this project was to devise an economically viable, highly energy-efficient continuous single unit operation for the remediation of poultry wastewater by uniquely combining smart membrane-based separation, liquid-liquid extraction and recovery of value-added products.

During the period of this project specific objectives were addressed and significant progress made toward the development of the new system. Membranes were developed possessing selective wettability, both hydrophilic (water loving) and oleophobic (oil hating), and photocatalytic ability by coating commercially available filters with photocatalytic titania (TiO2) nanoparticles. Parameters for successfully coating these membranes were studied and optimized. A novel continuous separation apparatus was engineered that consists of a mixer, an extractant, and two membranes operating in parallel. This allows continuous separation of oil-water mixtures by combining membrane-based and liquid-liquid extraction. Experiments were successfully conducted to establish the proof-of-concept that value-added products could be recovered after separation utilizing a commercial hydrophobic adsorbent.

The new apparatus has been tested using real wastewater from a poultry processing plant and performed well under laboratory conditions. Several aspects must be improved before it can be commercially successful, such as filter cleaning, filter durability and by-product recovery capacity. This research is very important to the future of the poultry industry because innovative new technologies are needed to improve the treatment of poultry wastewater. Such technologies can help the industry enhance its programs to reuse, conserve and recycle water.
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Research Provides New Understanding of ILT Vaccines

Dr. Jack Gelb, Jr.
University of Delaware, Newark, Delaware

Infectious laryngotracheitis (ILT) is a disease of great concern to the poultry industry. This acute respiratory disease is caused by an avian alpha herpesvirus, infectious laryngotracheitis virus (ILTV). The poultry industry does not universally embrace the use of live-attenuated chicken-embryo-origin (CEO) vaccines to control this disease, because CEO ILT vaccines can exhibit significant pathogenicity in young birds, with an associated economic cost. The observed pathogenicity of CEO ILT vaccines is inconsistent in the field, leading to a widely held belief that the illness seen in chickens following the use of CEO ILT vaccine results from improper administration and subsequent vaccine spread and back-passage. Vaccine back-passage is the enhancement of vaccine virulence as it spreads bird-to-bird. Therefore, better understanding of the cause of severe vaccine reactions following the use of CEO ILT vaccines is an important industry need.

CEO ILT vaccines have been shown to be a mixture of viruses with differing biological properties. In this study, two of these subpopulations of virus from a commercial CEO ILT vaccine, designated UDCEOD2 and UDCEOD3, were found to be nonpathogenic in broiler chickens. The specific objective of this research was to characterize these ILTV strains exhibiting reduced pathogenicity.

The viruses were found to lose viability upon passage in birds, embryonated eggs and in primary liver cell cultures. Two attempts were made to evaluate the dose and route of inoculation for vaccine studies. In both cases the titer of the virus was found to be too low to provide protection. Without the ability to establish immunity, experiments to evaluate the onset and duration of immunity were not possible. These highly attenuated strains of ILTV were passaged 20 times in birds. They did not increase in pathogenicity and demonstrated a decreased ability to replicate. It was not possible to passage these viruses multiple times in either embryonated eggs or in liver cell tissue culture.

The results support the hypothesis that ILTV CEO vaccines do not revert to virulence upon passage in birds. Highly attenuated strains of ILTV appear to have a limited ability to propagate in birds. Therefore, since vaccine stocks have been shown to be composed of a mixture of genetically related viruses exhibiting differences in pathogenicity, “reversion to virulence” may represent a competitive situation where more infectious (virulent) subpopulations in the CEO ILT vaccine outcompete those that are nonpathogenic and less able to replicate when improper vaccine administration allows vaccine spread and back-passage in the field.
Research Shows Practical Method to Reduce Litter Moisture

Dr. Michael Czarick

University of Georgia, Athens, Georgia

In today’s broiler industry producers are relying less on antibiotics and putting more attention on animal welfare than ever before. One result of this trend is that growers are being challenged to improve litter management. High litter moisture (>35%) has been correlated with increased risk factors related to bird health and welfare. Litter moisture can be reduced through proper drinker management and ventilation to maintain a low house relative humidity (Rh <50%). Though proper drinker management does not place a financial burden on the grower, the same cannot be said about ventilation rates required to maintain a low Rh. Depending on conditions, decreasing Rh by just 20% could increase heating costs by 45% due to the higher ventilation rates required.

A possible alternative to primarily using ventilation to control litter moisture could be maintaining a moderate Rh level (50-60%) and moderate level of air movement (150 feet/minute) across the floor on litter moisture, paw health and coccidia sporulation. A total of five flocks were studied on two commercial broiler farms (two houses per farm). One house on each farm did not use circulation fans (control), and an adjacent house (treatment) was equipped with eight 24-inch 1/3 horsepower circulation fans that operated continuously throughout the flock. Both houses on each farm were managed similarly and were ventilated to maintain a moderate Rh of 50-60%.

The objective of this study was to evaluate the combined effects of maintaining a moderate house Rh level (50-60%) and moderate level of air movement (150 feet/minute) across the floor on litter moisture, paw health and coccidia sporulation. A total of five flocks were studied on two commercial broiler farms (two houses per farm). One house on each farm did not use circulation fans (control), and an adjacent house (treatment) was equipped with eight 24-inch 1/3 horsepower circulation fans that operated continuously throughout the flock. Both houses on each farm were managed similarly and were ventilated to maintain a moderate Rh of 50-60%.

The study demonstrated that the combination of maintaining a house Rh between 50-60% and an average velocity at floor level of 150 feet/minute resulted in a more consistent environment throughout the house. During cold weather, when temperature uniformity tends to be more problematic, the treatment house temperatures differed by less than 5°F over 99% of the time, while control house temperatures varied less than 5°F only 50% of the time.

Thermal images showed areas beneath tube heaters in control houses often exceeded 120°F during colder weather, while in the treatment houses floor temperatures ranged between 85°F to 100°F. These differences in floor temperatures led to uneven bird distribution in the control house. Birds often gathered near sidewalls to avoid areas under the heaters in control houses, while birds were more evenly distributed in treatment houses. Differences in bird distribution influenced litter moisture profiles. By three weeks, litter moisture was often 20-25% in treatment houses versus 25-35% in control houses. Furthermore, sidewalls in treatment houses tended to be less than 25% in moisture versus >30% in control houses during the cooler times of the year.

With drier litter, footpad lesions were typically lower in treatment houses. By the end of each flock, usually less than 30% of birds scored showed signs of severe lesions in the treatment houses whereas over 50% of birds displayed signs of severe lesions in control houses. If a paw value of $1.00/pound is assumed, the treatment effect could have the potential to save up to $3,000 per year for a 25,000-bird house growing a 4.5-pound bird.

No significant differences in coccidia sporulation were noted between control and treatment houses, which demonstrated that drier litter conditions in the treatment house had no negative impact on oocyst sporulation rates.

The producers observed that ammonia levels were consistently lower in the treatment house. Ammonia measurements taken over the first four weeks of one flock found an approximate 50% reduction in ammonia concentrations in the treatment house versus control (15-25 ppm vs. 30-40 ppm).
Research Provides Insight on Colonization of Broilers by *Salmonella*

Dr. Kenneth S. Macklin and Dr. Sacit “Sarge” F. Bilgili

Auburn University, Auburn, Alabama

Insuring the safety of poultry products is a high priority to producers, consumers and regulatory officials. Broiler carcass contamination at the processing plant is difficult to avoid if chickens arrive at the processing plant contaminated with *Salmonella*. During rearing and processing of broilers, there are a variety of potential sources for *Salmonella* contamination. Several preventative strategies have been implemented with varying degrees of success; however, an understanding of the different potential entryways and resulting colonization sites needs further analysis so that effective control strategies can be developed.

The first objective of this project was to determine if *Salmonella enteritidis* (SE) and *Salmonella heidelberg* (SH) can cause a systemic infection when administered to broilers by various routes. In the first trial, broilers were provided with feed contaminated by *Salmonella* at a dose of 10^2 colony-forming units (CFU)/gram continuously starting at day 0 and lasting throughout the grow out (day 35). In a second study, broilers were fed contaminated feed at a higher level of SE or SH from day 14-18, produced lower overall levels of *Salmonella* contamination. However, SE was isolated from more than 50% of the exposed birds, while SH was isolated from only 2% of the exposed broilers. This was determined to likely be due to the inability of SH to survive for a long period of time on feed. In birds inoculated by various routes at day 0, the intratracheal, ocular and oral routes gave the highest recovery of *Salmonella* among the collected samples, while the subcutaneous route resulted in the lowest recovery.

It is important to note that all inoculations at 10^4 CFU resulted in some recovery from multiple organ and tissue samples when administered at day 0. In the birds that were inoculated at day 14, the groups inoculated by the ocular, intratracheal and cloacal routes had the greatest incidence of *Salmonella* recovery at day 35. These results show that introduction of SE or SH can occur at any point during the life of the flock.

As an enteric pathogen, the fecal/oral route has been the most commonly investigated route of inoculation. This research supports that route as being an important one; however, it also shows that aerosolization (intratracheal) is an important route for *Salmonella* colonization and potential spread throughout a poultry house. It was also concluded that the cecum is the best organ for *Salmonella* isolation; however, *Salmonella* has the potential to be found in any organ. These experiments also showed that *Salmonella* isolates vary in their ability to survive outside the host. The SE isolate used in these studies was recoverable four days after being inoculated onto feed, while the SH isolate was recoverable for only two days. This could be an important factor in determining the ability of a *Salmonella* isolate to spread through a poultry complex by means of contaminated feed.
Researchers Use Laser for Broiler House Enrichment

Dr. Elizabeth Bobeck
Iowa State University, Ames, Iowa

Today’s broiler spends much of the day inactive, and physical activity has been shown to improve leg health and reduce lameness. To promote movement, environmental enrichment may be added to broiler houses; however, few published studies have been able to show a positive effect of enrichment on bird activity without sacrificing performance outcomes. In this study a novel enrichment device was used to increase broiler movement, specifically through promoting natural instincts.

A novel laser environmental enrichment device was implemented throughout a 6-week grow-out cycle. It was hypothesized that the laser would stimulate natural predatory behavior in the broilers which, in turn, would increase locomotion and feeding. It was further hypothesized that the broilers’ leg health and growth rate would improve due to increased movement throughout the growth period. The objectives were therefore:

1) Validate quantitative methods to evaluate broiler bird welfare, specific to production (performance, leg lameness, breast blisters, footpad dermatitis, ammonia production, litter quality, behavior and movement outcomes); and 2) Evaluate experimental environmental enrichment using quantitative methods verified in Objective 1.

The unique laser enrichment device tested here not only significantly increased broiler activity (weeks 2-5) but improved performance outcomes including feed intake and weight gain, average daily gain and feed conversion ratio. Importantly, measures of bird welfare, including gait score, contact dermatitis score, tibia quality, and air and litter quality, were not negatively impacted by laser treatment. The consistently increased weight gain observed in the laser-enriched birds averaged to a greater end weight of 0.24 kg/bird on day 42. Improved feed conversion (a significant 18-point decrease in the finisher period) translates to greater than 5% reduction in feed costs. Finally, the laser device is practical to implement in commercial barns and does not require altered management or bird contact, allowing for ease of cleaning and use over multiple flocks.

Based on the utility of measures studied through Objective 1, a simplified measure of broiler behavior and quantification of distance walked are recommended in the commercial audit. Further, a novel gait-scoring platform tested here is recommended for research and commercial use. Measures of contact dermatitis should be adapted to include on-farm scoring, but measures of bone quality are suitable for research only. Recommendations are made for producers that can be used on farms to measure broiler welfare and recommendations are also made for updating currently used broiler welfare audit guidelines.
Research Provides Enhanced Safety of Poultry Products

Pathogens, such as *Salmonella enterica* and *Campylobacter jejuni*, on raw meat and poultry products are a major food safety concern to regulatory agencies, meat processors and consumers. Antimicrobial use during processing can provide significant reductions of pathogen numbers, but poultry skin is hydrophobic (due to its fat content) and can resist thorough wetting by commonly used water-based antimicrobials. This likely limits the effectiveness of the microbial treatment.

Development of a food grade acid/saponin sanitizer with GRAS chemicals for broiler carcasses would be attractive to the poultry industry because of the following attributes: chemical stability, convenience of use, free of detectable organoleptic properties at use levels, environmental safety and biodegradable. Saponins are produced by certain plants and have detergent surfactant characteristics that can facilitate efficient wetting of fatty surfaces such as poultry skin. Some saponins, such as those in extracts from *Yucca schidigera*, have FDA GRAS status and are approved for use as ingredients in foods and beverages. Although studies have been published on the effect of organic acid/surfactants on the inactivation of *E. coli*, the “multiple-hurdle” effect of organic acid/saponin on *Salmonella* and *Campylobacter* has not been evaluated on broiler skin. The long-term goal of this research project was to enhance poultry meat safety by developing approaches for cleaning deep skin pathogen contamination in poultry carcasses or parts.

The objective of the project was to evaluate the antibacterial efficacy of organic acid solutions alone or combined with selected saponins against *Salmonella* and *Campylobacter* in a laboratory broth medium and to then determine the antibacterial effectiveness of selected organic acid/saponin immersion treatments against pathogens and indigenous microflora on chicken skin. The antibacterial effectiveness of lactic/citric acid mixtures (1.5% and 2.5%) or acetic acid (1.0% and 2.0%), alone or combined with Yucca extract (YEX), was evaluated against a 5-strain mixture of *Campylobacter jejuni* and *Salmonella enterica* in laboratory medium and on raw chicken skin. Lactic/citric (2.5%), or 2.0 % acetic acid with added 0.5% YEX, exhibited the largest reduction in populations of *Campylobacter jejuni* and *Salmonella enterica* in vitro as well as on chicken skin (p < 0.05). The addition of YEX (0.5%) to Lactic/citric acid (2.5%) or to acetic acid (2.0%) can enhance the antibacterial activity of those organic acids against *Campylobacter jejuni* and *Salmonella enterica* on raw chicken skin. These results indicate that saponins may have a practical use in combination with organic acids for the reduction of pathogen contamination during processing.
Research Provides New Method to Detect Woody Breast Fillets

Dr. Amit Morey

Auburn University, Auburn, Alabama

The bioelectrical properties of breast fillets are significantly affected by woody breast myopathy and hence can be used to detect woody breast. The project was aimed at developing and validating a hand-held bioelectrical impedance analysis (BIA) tool for rapid detection of woody breast fillets. Woody breast fillets affected to varying degrees of severity were analyzed using the bioelectrical impedance analysis, proximate composition (protein, moisture and fat) and texture analysis. BIA measurements were taken at three different locations on the fillet to determine if there were differences in the electrical properties due to position. The BIA was then used to determine the accuracy of detection of the woody breast fillets by plant personnel.

Although there were no corresponding significant differences in moisture content or moisture lost during cooking, total body water was significantly higher in severely affected breast fillets than in normal breast fillets. This may explain the differences seen in electrical properties of severely affected woody breast fillets. BIA can be successfully used to detect normal fillets and severely affected fillets but does not differentiate between mildly and moderately affected fillets. When the BIA tool was used to evaluate fillets, which had been sorted by plant personnel into severely affected fillets and normal breast fillets, it indicated an accuracy of 89.80% by plant personnel in identifying the severely affected woody breast fillets. Approximately 10% of woody breast fillets were categorized as normal by plant personnel.

The bioelectrical impedance analysis method can be used effectively to differentiate between normal and severely affected woody breast meat. Quality assurance personnel can use it as an efficient hand-held system to ensure the quality of meat being sent to the customers. This method can reduce human error in sorting breast fillets. Companies can use this device to determine the percentage of normal and severely affected woody breast fillets and track trends by season, farm or management practices. Genetics companies can potentially use this technology to help identify woody breast in the genetic selection process.
Research Provides Insight on How to Improve Indoor Air Quality in Poultry Housing with Black UV Light

Dr. Jacek Koziel

Iowa State University, Ames, Iowa

Gaseous emissions are an unwanted side effect of poultry production. It is essential to mitigate ammonia and other gaseous emissions to increase industry sustainability. In general, the components of gaseous emissions are composed of volatile organic compounds (VOCs), greenhouse gases (GHGs: CO₂, CH₄, and N₂O), ammonia (NH₃) and hydrogen sulfide (H₂S). Emissions of VOCs cause odor in the local air quality. Emissions of odorous NH₃ and H₂S are important because of their quantity and toxicity, respectively.

The main objective was to develop and test a novel mitigation technology for ammonia and odor concentrations and barn emissions based on black UV light (a milder version of UV) and a special chemical coating for barn ceilings, barn walls and barn exhaust fans. Lab-scale experiments involved testing the effects of the treatment time required to effectively reduce ammonia and odor in the fast-moving odorous air. Pilot-scale testing involved analyzing the effects of the treatment time and black UV light energy required to reduce ammonia and odor in the fast-moving odorous air effectively from a real poultry barn.

The main results of this research project showed a reduction in gaseous emissions, including ammonia, in the laboratory study and the pilot-scale study. In addition to the environmental effects, at high concentrations these gases can be irritating to mucous membranes of the respiratory tract and the conjunctivae and corneas of the eyes of birds. High levels also have a negative impact on overall livability, weight gain, feed conversion, condemnation rate at processing and the immune system of the birds. Therefore, these results can be used for future research involving perfecting this mitigation technology for: (1) air quality improvements, (2) improving poultry-wellbeing and feed conversion efficiency, (3) improving biosecurity, and (4) reducing greenhouse gas emissions.
Research Provides Alternatives to Maceration of Day of Hatch Male Layer Chicks

Dr. Morgan Farnell
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In the egg industry, the sex of day-old chicks is determined at the hatchery. Male layer chicks, unwanted sexes from breeding lines and broiler chicks with lethal deformities or inability to pip must be euthanized humanely at the day of hatch. Currently, instantaneous mechanical destruction (maceration) is the predominant euthanasia method used in poultry hatcheries and approved by the American Veterinary Medical Association (AVMA). However, it is not always perceived by the public to be a humane means of euthanasia.

The welfare of neonatal chicks euthanized by these alternative methods was evaluated through behavioral and physiological responses.

The alternative euthanasia methods evaluated included carbon dioxide (CO2), nitrogen (N2) and a vacuum system to euthanize day-of-hatch male layer chicks. In the laboratory phase, male layer chicks were subjected to breathing air, 25% CO2, 50% CO2, 75% CO2, 90% CO2, 100% N2 and an experimental vacuum system. Chicks recovered from the exposure to the 25% and 50% CO2 treatments. The CO2 treated chicks (either 75% or 90%) spent less time to lose posture and to reach motionlessness than chicks treated by the vacuum system or N2 inhalation. However, there were no statistical differences among 75% CO2, 90% CO2, 100% N2 and vacuum treatments in the level of stress hormones detected in the chicks. In the field study, male layer chicks were subjected to breathing air, CO2, N2 and a low atmospheric pressure stunning (LAPS™) system in a commercial chamber. The N2 treated chicks spent more time to initiate ataxia, loss of posture, convulsions and motionlessness and demonstrated higher corticosterone levels; whereas the LAPS™ system and the CO2 methods induced unconsciousness of chicks quicker without increasing stress levels. Interestingly, the CO2 treatment increased the hormone responsible for eliciting a sense of well-being in chicks compared to the other treatments.

The data collected suggests that both CO2 and vacuum treatments could be considered as alternatives to maceration to euthanize day of hatch chicks humanely and quickly on a commercial scale. The investment of the chamber, gas cost and worker safety/training may be short-term drawbacks for these methods. These methods have been shown to be humane alternatives.
Research Examines Alternative Feeding Programs and Photostimulation Periods for Broiler Breeders

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While the current restricted feeding programs, such as skip-a-day feeding, improve the economic efficiency of broiler breeder operations and increase the numbers of broilers produced by the industry, this management practice of feed restriction impacts animal welfare. Feed restricted birds show signs of chronic hunger and biological distress. Previous research examined different strategies to minimize this stress, including diet dilution, spin feeding and the use of appetite suppressants. Consumers are increasingly concerned about how and under what conditions the animals in the food system are raised. These consumers show increased interest in more “natural” rearing conditions in animal agriculture. Therefore, the basis of this research was to examine two different rearing growth curves/photostimulation ages and two different feeding regimes. This research looked at the impact of (a) advancing the age of photostimulation (15 weeks) and corresponding attainment of the target body weight (2.1 kg) on reproductive efficiency in broiler breeders. Additionally, (b) it investigated the effectiveness of the natural feeding practice of spin feeding on birds under the two different growth curves.

Results from this trial demonstrated that age at sexual maturity in broiler breeder pullets can be significantly advanced with the use of a less restrictive growth curve during rearing to reach target body weight and surpass the trigger for sexual maturation as early as 15 weeks of age. Data also showed that there are production advantages to using every day spin (EDS) feeding during rearing that could benefit consumer perception of poultry production by utilizing a feeding method that allows for birds to utilize their natural foraging behavior. Although the advancement of age for sexual maturation and egg production didn't result in a greater number of eggs produced, it did show proof that a feeding strategy could possibly be optimized for birds to improve egg production that could match or surpass standard rearing and photostimulation practices. The birds photostimulated at 15 weeks of age were at a heavier weight upon age at first egg, and that likely contributed to the comparatively poorer egg production numbers and may have potentiated the increase in that group's mortality. There was no overall impact on fertility when both pullets and cockerels were brought to sexual maturity 6 weeks earlier than standard commercial conditions.

A better understanding of the underlying mechanisms behind the metabolic trigger for the onset of sexual maturation or the development of an optimized feeding strategy for early photostimulation would improve egg production in the hens photostimulated at 15 weeks while allowing for a relaxed feed restriction program during rearing. With an optimized feeding strategy, the shortening of the rearing period could be economically beneficial as it would shorten the period of no return and lengthen the productive period for hatching egg production. These results indicate that there is potential with this alternative strategy to rearing broiler breeders.
Food safety and sanitation is of paramount importance to the poultry processing industry. Sanitizers, both inorganic (e.g., chlorine-based products) and organic (e.g., quaternary ammonium compounds), have been widely and effectively used by the poultry processing industry to control food-borne agents. Recently, peracetic acid (PAA) has been an effective antimicrobial agent in the poultry industry, used predominantly in chillers, while its use has recently been expanded to other unit processes. Poultry processing personnel refer to upsets of biological wastewater treatment processes and whole effluent toxicity (WET) test failures potentially caused by an excessive use of PAA, thus making it hard to meet effluent discharge requirements. Despite the potential negative impacts on effluent quality and the rapidly increasing use of PAA in poultry processing plants, no detailed information has been available relative to the fate and effect of PAA in poultry processing wastewater treatment systems. The overall goal of this research project was to systematically assess the fate of PAA solutions in poultry processing waste streams, their effect on biological treatment processes typically used by the poultry processing industry and develop an effective methodology to mitigate any negative effects.

This research project accomplished the following tasks: 1) Tested and adopted effective analytical methods for the detection and quantification of PAA and hydrogen peroxide (H2O2) in complex poultry processing wastewater matrices; 2) Assessed the degree/extent of PAA carryover into various poultry processing waste streams and its stability in such streams; 3) Quantified PAA decay rates under various conditions encountered in poultry processing wastewater systems (i.e., pH, wastewater strength and protein content, initial PAA concentration, and temperature); and 4) Bench-scale, batch assessment of the effect of PAA on the treatment efficiency of aerobic, nitrifying, denitrifying, and anaerobic processes.

Three analytical methods for the effective detection and quantification of PAA and H2O2 in complex waste streams were evaluated and used. Key findings of the project showed that PAA was detected in chiller drain samples at potentially impactful levels; PAA carryover to poultry processing effluent occurs, especially at the end of the processing shift during the emptying of chillers; very high initial PAA demand was observed of chiller drain, poultry processing wastewater samples; and PAA decomposition in poultry waste streams was primarily affected by pH, and secondarily by wastewater strength, wastewater protein content, and initial PAA concentration.

This study documented PAA carryover into various poultry processing waste streams, its decomposition in such streams, as well as its short-term effect on the treatment efficiency of biological aerobic, nitrifying, denitrifying and anaerobic degradation processes. Such information enhances our understanding relative to the fate and effect of PAA solutions in poultry processing wastewater treatment systems, information crucial for the rational design and operation of biological treatment processes, especially those related to biological nutrient removal. The outcome of the present study provides systematic information to the poultry processing industry to develop a sound methodology and employ other measures that will ensure the continuous use of PAA solutions to achieve pathogen-free products, while avoiding upsets of biological processes used for the treatment of PAA-bearing wastewater.
Dr. Kenneth Anderson Receives 2019 Dr. Charles Beard Research Excellence Award

USPOULTRY and the USPOULTRY Foundation recognized Dr. Kenneth Anderson as the 2019 recipient of the annual Dr. Charles Beard Research Excellence Award. Dr. Anderson is a professor in the Prestage Department of Poultry Science at North Carolina State University. 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 selected Dr. Anderson for this award based on his exceptional research on mass depopulation methods to reduce animal suffering in poultry. Dr. Anderson worked to understand how heat and carbon dioxide can be added to the process known as ventilation shutdown to quickly reduce animal suffering when euthanizing large populations of chickens and turkeys to stop the spread of devastating diseases such as avian influenza and Newcastle disease. This process, now known as VSD-plus, has been accepted by the authorities at U.S. Department of Agriculture Animal and Plant Health Inspection Service (USDA-APHIS) as an approved method of mass depopulation in times of disease outbreaks, which is a tremendous improvement over previously approved methods. Dr. Anderson’s research formed the basis for the policy decision by USDA-APHIS. Dr. Anderson’s research has been supported by three grants from USPOULTRY and the USPOULTRY Foundation, which have allowed him to also demonstrate and teach the correct methods to conduct VSD-plus to both the regulatory officials and the poultry industry.

“The U.S. Poultry & Egg Association has been very supportive of our research program over the years, and I am very grateful for this support. The support of the Association has helped us to make meaningful advances in the development of improved methods of humane depopulation,” commented Dr. Anderson.

“Dr. Anderson’s research program is a great example of how USPOULTRY research funds can be directed toward important applied research to find solutions to current problems faced by the poultry industry. The quality of Dr. Anderson’s research is outstanding, and the results will be used by the poultry industry to make improvements in the response to devastating disease outbreaks,” remarked Dr. John Glisson, retired vice president of research programs for USPOULTRY.

Dr. Anderson received his BS degree from Southern Illinois University and his MS and Ph.D. degrees from Kansas State University. He joined the faculty at North Carolina State University in 1990.

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, Dr. Anderson received a $1,500 cash prize. The award was presented to him during the USPOULTRY Chairman’s Reception by Dr. Charles Beard with Tom Hensley, Fieldale Farms, and past USPOULTRY Foundation chairman, assisting with the presentation.

From left: Dr. Kenneth Anderson, Tom Hensley and Dr. Charles Beard