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## **2006 PROGRESS REPORT:**

### **Objective 1: Poultry Meat Safety**

**Accomplishment 1.** Following electrical stunning, the decapitation of broilers during bleed-out was demonstrated not to significantly increase respiratory tract bacterial contamination during immersion scalding, nor to impede defeathering ability, or to alter carcass quality.

**Impact Statement 1.** Decapitation of electrically stunned broiler chickens is being utilized commercially and thereby eliminates the potential animal welfare concern that stunned broilers may regain consciousness prior to death during bleed-out.

**Accomplishment 2.** Comparison of genetically featherless and feathered broiler chickens during processing through immersion chilling revealed no significant differences in the incidence and level of recovery of *Salmonellae*, *Campylobacter*, *E. coli*, or total aerobic bacteria from defeathered or immersion chiller carcasses.

**Impact Statement 2.** The presence of feathers and feather follicles during processing and immersion chilling appears to have minimal influence on the incidence and level of recovery of food borne pathogenic bacteria from carcasses, and therefore carcass decontamination intervention efforts can be directed elsewhere (away from empty feather follicles).

**Accomplishment 3.** The incidence of unabsorbed yolk sacs in present day commercial broilers appears twice as high as for mature broiler roosters, table egg laying hens, or broilers with 1950's genetics (Athens-Canadian Randombred Controls). Unabsorbed yolk sacs are colonized

by bacteria and may also serve as a reservoir for the subsequent pathogen recolonization of the intestine or contamination of the abdominal cavity if ruptured during processing.

**Impact Statement 3.** At a high incidence of 49 % for unabsorbed yolk sacs in commercial broilers at the time of processing, yolk sacs and the recovery of both *Campylobacter* and salmonellae could be a potential route for carcass *Campylobacter* and salmonellae contamination during processing. However, considering that the vast majority of the unabsorbed yolk sacs were detected intact and attached to the intestine (61 to 75 %) and of these, 78 to 88 % were classified as small, that leaves only 4 % of the yolk sacs detected unattached and classified as large to result in carcass contamination if ruptured during evisceration, and thereby only a minor source of contamination.

**Accomplishment 4.** Because of noisy signals from commercial multispectral cameras, a new compact multispectral imaging system was designed and assembled with stereo imaging using replaceable optical filters and sensors. The compact system is composed of beam splitter, lenses and high resolution cameras.

**Impact Statement 4.** Initial tests proved the compact system could acquire high speed, high quality registered spectral images. This compact system can be further developed for hand-held fecal contaminant detection.

**Accomplishment 5.** Unwanted bones in boneless poultry breast fillets are a serious safety problem resulting in numerous injuries every year. An optical technique to detect bone fragments embedded in poultry breast fillets was developed.

**Impact Statement 5.** The method reduces the scattering effects of the breast meat and uses an image processing algorithm to enhance the image of the bone for improved detection.

**Accomplishment 6.** Previous studies demonstrated an imaging system with optimal thresholding for spectral image ratio was effective for detecting fecal contaminants on the surface of broiler carcasses. However, differentiating false positives from contaminants was always challenging for the imaging application. Therefore, in addition to image processing in the spatial domain, further processing in the frequency domain can help to identify false positives. In order to remove false positive errors, textural analysis method was developed.

**Impact Statement 6.** This method can identify contamination regardless of fecal source (duodenum, ceca, or colon) and diets (corn, wheat, milo with soybean mixture) for maximizing detecting accuracy and minimizing errors.

**Accomplishment 7.** Research was conducted to determine the suitability of using white LED light as a light source for hyperspectral and multispectral imaging. The LED sources are cool, long-lasting, and have a much higher light output than traditional LEDs.

**Impact Statement 7.** LEDs are a good alternative for applications in the visible light range but not as well suited for imaging in the near-infrared region.

**Accomplishment 8.** Antimicrobial treatments were tested for efficacy against poultry pathogens. Spraying poultry carcasses with the following treatments did not enhance removal of pathogens: 1) lactic acid bacteria and nutrient solutions; 2) a blend of citric, hydrochloric, phosphoric acids; and 3) chlorinated water at different temperatures. Microbicidal activity was observed *in vitro* and on poultry skin for potassium hydroxide and lauric acid mixtures.

**Impact Statement 8.** Results suggested which antimicrobial treatments are efficacious against pathogenic bacteria and are worth further study.

**Accomplishment 9.** The microbiological impact of immersion chilling of poultry with lower volumes of water was assessed. Lower numbers of pathogens were recovered from inoculated carcasses after chilling in a high volume of water (16.8 L/kg) as compared to carcasses chilled in a low volume of water (2.1 L/kg).

**Impact Statement 9.** Water use is associated with expense and environmental impact. These experiments indicated the range in which chill water volume affects carcass microbiology.

**Accomplishment 10.** Evaluated microbiology of water from a multiple-tank scalding operating under different conditions from previous reports. Numbers of coliforms, *E. coli*, and *Campylobacter* on carcasses are sharply reduced in the third tank compared to the first tank (as much as a 3 log reduction in numbers) with a reduction in incidence of *Campylobacter* and *Salmonella* in water from successive tanks. Bacteria in scald water do not predict incidence of bacteria in rinses of defeathered carcasses.

**Impact Statement 10.** Microbiological benefits of multiple-tank scalding were demonstrated.

**Accomplishment 11.** Recovery of pathogens from pre-chilled poultry carcasses was evaluated before washing or after a 1 minute wash in either sterile water or a solution containing a high level of chlorine (500 ppm). When compared to sterile water, chlorine reduced levels of aerobic bacteria, *E. coli* and coliforms by 1.3, 0.6 and 0.6 log<sub>10</sub> cfu/mL rinse, respectively; however, carcasses washed with sterile water and chlorine had the same incidence (number of samples positive) of *Salmonella*.

**Impact Statement 11.** Chlorine in prechill carcass rinses reduced numbers of indicator bacteria but had no impact on incidence of *Salmonella*.

**Accomplishment 12.** Tested electrolyzed water in inside-outside bird washers against spoilage bacteria and yeasts.

**Impact Statement 12.** Determined that acidic electrolyzed water can be effectively be used in inside-outside bird washers to decrease the population of spoilage bacteria and yeasts on processed broiler carcasses.

**Accomplishment 13.** Tested capability of volatile fatty acids placed into the cloaca of carcasses before defeathering to reduce *Campylobacter* contamination of broiler skin.

**Impact Statement 13.** Determined that volatile fatty acids can reduce *Campylobacter* contamination of broiler skin during defeathering operations when solutions of the acids are placed into the cloaca of the processed carcasses.

**Accomplishment 14.** Tested selected organic acids for ability to support the growth of *Campylobacter* *in vitro*.

**Impact Statement 14.** Determined optimal concentrations of selected organic acids that can be used to support the growth of *Campylobacter*.

**Accomplishment 15.** Recent FSIS reports have emphasized on-farm microbiological intervention strategies to reduce in-plant product contamination. Various litter sampling techniques were tested for detecting *Salmonella* in market-age broiler chickens. In addition, a survey of *Salmonella* incidence in samples from on-farm broilers (external rinse versus cecal contents) was completed.

**Impact Statement 15.** Some litter sampling methods are much better at detecting *Salmonella* in poultry flocks at the farm. Better detection may lead to better and more timely interventions.

**Accomplishment 16.** On-going project with U.S. Poultry & Egg Association to compare microbiology and quality of poultry after immersion or air chilling. Levels of pathogens recovered from non-chlorinated immersion chilled carcasses were not significantly different from the levels recovered from dry air chilled carcasses. Air chilled carcasses had darker skin color and lost approximately 2% in yield during chilling, while immersion chilled carcasses absorbed 8 to 9% water.

**Impact Statement 16.** Results will guide decisions concerning use of different chilling systems.

**Accomplishment 17.** Initiated experiments designed to partition *Salmonella* incidence and numbers in external samples (feathers, skin, feet, head) versus internal samples (crop, ceca, colon and cloaca) of broilers after transportation to the processing plant.

**Impact Statement 17.** Knowing the incidence and numbers of *Salmonella* bacteria in different areas of incoming carcasses will allow focused interventions to remove contamination and reduce cross-contamination.

**Accomplishment 18.** Initiated experiments designed to reduce the amount of fecal material deposited in the scalding tank during processing. Full-fed broilers were processed and fecal material was forced from carcasses prior to scalding using a prototype commercial evaluation device.

**Impact Statement 18.** Forced evacuation significantly reduced carcass weight and the level of total solids deposited in the scalding tank.

**Accomplishment 19.** During broiler feed withdrawal, the pH of the crop increases and the environment becomes more favorable for *Salmonella*. *Salmonella* is then available to contaminate carcasses during processing. Research was conducted to determine that feed supplemented with botanical probiotics containing lactobacilli can support growth of broiler chickens as well as feed supplemented with antibiotics and coccidiostats.

**Impact Statement 19.** Feeds that maintain crop pH can inhibit the increase in crop *Salmonella* incidence that is seen after feed withdrawal.

### **Objective 3: Egg Quality and Safety**

**Accomplishment 1.** Studies were conducted to examine the presence of aerobic organisms, *Enterobacteriaceae*, *Salmonella*, *Campylobacter*, and *Listeria* on vacuum loader suction cups and packer head brushes in 2 shell egg processing facilities. *Salmonella* and *Campylobacter* were found on 3% and 1%, respectively, of the suction cups sampled. *Listeria* was isolated on 72% of

the suction cups. No pathogens were recovered from eggs. Higher numbers of aerobic bacteria and *Enterobacteriaceae* were recovered from washed eggs when > 4.0 log cfu aerobes/ml or >2.0 log cfu *Enterobacteriaceae*/ml per sample were recovered from packer head brushes.

**Impact Statement 1.** These findings will lead to more effective plant sanitation practices.

**Accomplishment 2.** Studies were conducted to examine the effectiveness of periacetic acid and chlorine as shell surface sanitizers. Solutions were applied to the surface of visibly clean, unwashed eggs. *Enterobacteriaceae* prevalence was reduced 20-50% with periacetic acid compared to the other treatments. When a mechanical nano-atomizer was used to apply the periacetic acid, *Enterobacteriaceae* prevalence was reduced 94%. A 200 ppm chlorine solution was less successful when applied in the same manner.

**Impact Statement 2.** Periacetic acid is a promising sanitizer for shell eggs.

**Accomplishment 3.** Bacterial populations were determined on restricted shell eggs destined for the egg products industry. Restricted eggs are those which do not meet quality standards to be sold as shell eggs. All shell/membrane emulsion and contents pools were positive for aerobic organisms (>4.5 log cfu/ml and > 2 log cfu/ml, respectively). *Enterobacteriaceae* were detected in 99% of shell/membrane emulsion pools and 29% of egg contents pools. *Listeria* was detected in 36% of shell/membrane emulsion pools and 5% of contents pools. *Salmonella* and *Campylobacter* were isolated from 2% and 1%, respectively, of shell/membrane emulsion pools.

**Impact Statement 3.** Numbers and incidence of indicator and pathogenic bacteria were determined on restricted shell eggs.

**Accomplishment 4.** *Enterobacteriaceae* were recovered from 98% of nest run cart shelving in shell egg processing plants (mixed and off-line operations). On average, 3.4 log cfu/cm<sup>2</sup> were recovered per shelf, with bottom shelves dirtier than top-most shelves (4.1 v. 2.5 log cfu/cm<sup>2</sup>). *Enterobacter* and *Escherichia* were the most commonly identified genera. Others included *Citrobacter*, *Hafnia*, *Klebsiella*, *Kluyvera*, *Leclercia*, and *Salmonella*; *Pseudomonas* was the only non-*Enterobacteriaceae* genus identified and is commonly associated with egg spoilage.

**Impact Statement 4.** Knowing genera and numbers of *Enterobacteriaceae* may be useful in judging adequacy of sanitation programs.

**Accomplishment 5.** The preliminary portion of a retail survey of varying types of shell eggs was conducted. The eggs were examined for the prevalence of several food borne pathogens as well as the enumeration of aerobic populations and *Enterobacteriaceae*. Physical quality factors such as Haugh units, vitelline membrane strength, shell strength and thickness, total solids, ash and fat were also monitored.

**Impact Statement 5.** Information from this preliminary study will be utilized to develop a regional retail study involving cooperators from several universities in the Southern US.

**Accomplishment 6.** The presence of blood inside eggs is considered a quality issue, where table eggs are routinely screened, usually manually, and most are removed from the food supply; hatching eggs, however, are not screened or removed. Blood presence could be a food safety problem if it protects or encourages growth of pathogenic bacteria that contaminate the egg. Since billions of eggs are produced annually for food, the small percentage of blood eggs not removed could be a threat. Hatching eggs could be an important source of vertical transmission

of pathogens to broiler flocks. A preliminary experiment was conducted to determine if *Salmonella* inoculated into egg albumen with blood, would survive or grow better than albumen without blood. Findings indicate slightly higher recovered counts from albumen with blood.

**Impact Statement 6.** Better and more accurate systems for detecting blood eggs, such as spectral imaging, can be developed for the table egg industry and for hatching eggs.

**Accomplishment 7.** Blood spots, meat spots, and eggshell checks and cracks are significant problems for the table egg industry. Research was conducted to develop an inexpensive imaging system to detect blood spots, meat spots, and eggshell cracks.

**Impact Statement 7.** Results were promising for blood spots and eggshell cracks but more research is needed to identify meat spots in table eggs.

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