**215 Application of lactic-acid-producing bacterial cultures to skin of live broilers.** J. A. Cason*, R. J. Buhr, A. Hinton, Jr., M. E. Berrang, and N. A. Cox, *Russell Research Center, Athens, GA USA*.

In four trials, lactic-acid-producing bacterial cultures were applied to the skin of live broilers 24 h before slaughter to determine whether inoculation of the cultures could affect the numbers of bacteria that are normally found on the skin of processed broiler carcasses. The cultures contained 10,000 to 100,000 cfu/mL and were sprayed in 250 mL of a pH 6.0 nutrient medium (including glucose, peptone, beef extract, yeast extract, a surfactant, and salts) to enhance the growth and survival of the cultures. With broilers suspended by the feet, feathers were moved aside to apply as much of the liquid as possible directly to the skin. Sprayed broilers were then returned to a pen. In each trial, 4 five-wk-old broilers were sprayed and 4 broilers were kept as untreated controls. The following day, broilers were processed in a research processing facility and defeathered carcasses were sampled by rinsing for 1 min in 100 mL of peptone water after removal of heads and feet. Coliforms, E. coli, lactic-acid bacteria, and Campylobacter were enumerated by standard methods. After removal of aliquots for plating, the remaining sample volume was enriched to detect salmonellae. No differences were found in log10(cfu/mL) of coliforms, E. coli, or lactic-acid bacteria between the treated and control carcasses. All carcasses were Campylobacter-negative. Salmonellae were present on some carcasses, but with no differences between treatments. Spraying lactic-acid-producing bacteria with nutrients on the skin of live broilers appears to have no effect on numbers of bacteria that are present on the skin after defeathering.

**Key Words:** Lactic acid bacteria, Skin, Broilers

**216 Microbiological consequences of skin removal prior to evisceration of broiler carcasses.** M. E. Berrang*, R. J. Buhr, and J. A. Cason, *USDA-ARS-Russell Research Center*.

The skin of broilers can harbor high numbers of bacteria. If broiler processing could be altered such that the skin is removed early like feathers, feet and heads, perhaps a large proportion of these bacteria could be left behind. The objective of this project was to determine if removal of skin prior to evisceration lowers the number of bacteria that can be recovered by whole carcass rinse or outer surface sponge sampling. Two sets of experiments were conducted, one with each type of sampling (rinse or sponge). On each of three replicate sample days, ten New York dressed carcasses were obtained from a commercial broiler processing plant, five were aseptically skinned and five were left with skin intact. On each carcass, the esophagus was tied and cut above the proventriculus allowing the crop to be removed toward the head to prevent contamination of the body cavity. The carcasses were then aseptically eviscerated by hand. Carcasses were either rinsed in 100 mL sterile water or sampled by moist sponge over the outer surface. Serial dilutions from the rinse or sponge were plated on Campy cefex agar, *E. coli* petrifilm plates and plate count agar. Data are reported as mean $\log_{10}$ cfu per sample. When sampled by rinse, 5.4 *Campylobacter*, 4.4 *E. coli* and 6.7 total aerobic bacteria were recovered from carcasses with intact skin. Significantly less *Campylobacter* (4.7) and total aerobic bacteria (5.8) were recovered from skin-off carcasses. No difference in E. coli counts was noted for whole carcasses rinsed without skin (3.9). When sampled by sponge, 4.5 *Campylobacter*, 3.7 *E. coli* and 5.6 total aerobic bacteria were recovered. Significantly less *Campylobacter* (2.0), *E. coli* (2.3) and total aerobic bacteria (3.3) were recovered from carcasses without skin. Although not commercially practical, it is possible to lower the level of bacteria including *Campylobacter* on the outside of broiler carcasses by removal of the skin prior to evisceration.

**Key Words:** Broiler skin, *Campylobacter*, *E. coli*

**217 In Plant Microbial Profile of Air Chilled Chickens.** W. M. Fluckey*, M. X. Sanchez, M. M. Brashears, E. Wallner-Pendelton, A. Aguilar, M. Tamayo, and S. R. McKee, *University of Nebraska, Lincoln, NE*.

Many factors influence the microbial profile of chicken carcasses at retail. These factors include growout conditions at the farm as well as plant processing methods. To date there has been little data available to establish a microbial baseline for the air chilling poultry process in the U.S. because this method of chilling is primarily used in Europe. In a one-year period, birds representing 24 farms were evaluated for total aerobic microorganisms, coliforms, psychrotrophs, generic *E. coli*, *Salmonella* spp. and *Campylobacter* spp. Broilers were sampled at three sites during processing: before evisceration (BE), after evisceration (AE), and after chill (AC). Approximately a 0.5 log reduction in aerobes, coliforms and generic *E. coli* was observed AE compared to BE. An additional 0.5-1-log decrease in these populations was observed AC. *Salmonella* spp. and *Campylobacter* spp. enumeration was more variable. When *Salmonella* and *Campylobacter* counts were high, decreases in populations occurred AE and AC. Most often, higher prevalence of *Salmonella* and *Campylobacter* in the plant was related to flocks that came from farms with an open pond water source contaminated with these pathogens. This data suggest that water source contamination on the farm may play a larger role than higher counts of *Salmonella* and *Campylobacter* found in the plant and that numbers of bacteria on chicken carcasses are reduced as the birds proceed through the processing environment. Although there is a reduction in bacteria during processing, high initial loads of bacteria on carcasses entering processing facilities equates to higher bacterial loads after processing.

**Key Words:** Air chilling poultry, *Salmonella*, *Campylobacter*

**218 Development of Time/Temperature Indicator Tags for Tracking Poultry Product Quality Throughout the Cold Chain.** C.M. Moore*[1] and B.W. Sheldon[1], [1]*North Carolina State University, Raleigh, NC/USA*.

Time-temperature integrators (TTIs) offer a means of continuously monitoring the temperature of a food product from the point of manufacture to the consumer's refrigerator. TTIs readily indicate temperature abuse and are used to clearly indicate the end of shelf life based on the product's temperature exposure. Currently, no work has been published on the application of TTI's to poultry products. This study was conducted to develop and validate VITSAB-Cox-brand TTIs for monitoring fresh chicken quality throughout the cold chain. VITSAB-Cox TTIs change color from green to yellow to indicate the end of shelf life. Chroma [$\sqrt{(a^2 \text{ plus } b^2)}$] was used to objectively indicate TTI progress. Total bacterial plate counts and *Pseudomonas* species counts were used as quality indicators for chicken drumsticks. Raw chicken drumsticks (n = 4) and VITSAB TTIs (n = 5) were stored at four constant temperatures to identify their Arrhenius activation energy ($E_a$) which is a measure of temperature sensitivity. The $E_a$ for Pseudomonas and for the total indigenous population were determined to be 21.7 ($r^2$ = 0.94, SE=3.8) kcal per mole and 22.5 ($r^2$ = 0.97, SE = 2.9) kcal per mole, respectively. The $E_a$ for the TTI based on its chroma was determined to be 19.8 ($r^2$ = 0.98, SE = 2.2) kcal per mole. Shelf life studies were conducted at constant temperatures (3C and 4.5C) and under fluctuating temperature conditions (stepwise change between 4.5C and 14.5C) with TTIs attached to individual packages of drumsticks. For both constant and variable temperature studies, the TTIs correctly indicated the end of the drumsticks' shelf life. The chroma readings were significantly correlated ($p \leq 0.0001$) to Pseudomonas populations [r = 0.85 (4.5C), r = 0.93 (3C), r = 0.77, 0.87(variable temperatures)] and total microbial growth [r = 0.86 (4.5C), r = 0.93 (3C), r = 0.8, 0.91(variable temperatures)]. These findings demonstrated that the VITSAB-Cox TTIs were effective in predicting the end of shelf life of refrigerated and temperature-abused chicken drumsticks as defined by Pseudomonas and total aerobic bacterial populations.

**Key Words:** Time Temperature Indicators, Poultry Products, Shelf Life Prediction

**219 Effects of three packaging systems on the natural microflora and acceptability of fresh broiler breast meat.** Nadege Charles and Sally K. Williams*, *University of Florida, Gainesville, FL/U.S.A.*.

A study was conducted to investigate the effects of three packaging systems on the spoilage microflora, objective color and sensory characteristics of fresh commercial broiler chicken breast meat packaged for retail marketing. Fresh chicken broiler breasts were purchased from a local poultry processing plant and packaged in either (1) conventional styrofoam tray with polyvinyl chloride over-wrap and absorbent pad (PAD), (2) styrofoam tray with polyvinyl chloride over-wrap minus the

pad (PAD), or (3) Fresh-R Pax $^{TM}$ container (FRP) equipped with absorbent liner-gel system. All packages were heat sealed and stored at 1.21 C for 8 d. At each sampling period (0, 2, 4, 6 and 8 d), three packages from each treatment were analyzed for *Pseudomonas sp.* and psychrotrophic organisms, objective color and sensory characteristics. The data revealed similar results for all packaging systems. In general, the *Pseudomonas sp.* and psychrotrophic counts increased as storage time increased for all packaging systems. The color and sensory characteristics (i.e., odor and overall appearance) were similar for all packaging systems. While the absorbent pad used in the conventional tray-pack system and the absorbent liner-gel system incorporated into the Fresh-R Pax $^{TM}$ did not function to control microbial growth, they maintained aesthetic appeal by absorbing all visible moisture released from the meat during storage. This study also suggested that the Fresh-R Pax $^{TM}$ system would function well in reducing free purge in bulk packaged fresh meat and poultry, especially during transport.

**Key Words:** Packaging, Microbiology, Shelf life

**220 Effect of packaging systems on bacteria survival on processed poultry.** J. A. Byrd*[1], A.R. Sams[2], D.J. Caldwell[2,3], L.F. Kubena[1], and B.M. Hargis[2,3], [1]*USDA-ARS, Southern Plains Agricultural Research Center, College Station, TX, 77845,* [2]*Texas A&M University, Department of Poultry Science,* [3]*Texas A&M University, Department of Veterinary Pathobiology, Texas Agricultural Experiment Station*.

Previosuly, we evaluated the effects of modified atmosphere packaging (MAP) gases on the survival of naturally occurring *Campylobacter* on raw poultry and found that $O_2$ was the most effective in reducing the bacteria. Presently, we evaluated the effects of packaging methods on the survival of naturally occuring *Campylobacter*, aerobes, and psychrophiles on whole or parts of raw poultry. Whole or parts from broiler carcasses (400) were packaged with MAP, ice pack, chill pack, vacuum pack or frozen and sampled for detection of *Campylobacter*, psychrophiles, and total aerobes at 0, 2 and 14d of refrigerated ($2^oC$) storage. MAP gases evaluated were 100% $O_2$ and a standard mixture (5% $O_2$ + 10% $CO_2$ + 85% N). The rinse fluid was recovered, pooled from 5 individual rinses, and serial dilutions made for examination of *Campylobacter* (campy-cefex, $42^oC$, 48h), psychrophiles (plate count agar, $4^oC$, 7d), and total aerobic bacterial populations (plate count agar, $37^oC$,24h). *Campylobacter* counts for all treatment were reduced during the 14d storage period but the $O_2$ and frozen treatments caused a significantly ($P<.05$) greater reduction than the the other treatments. Storage for 14d in chill or ice packs resulted in the greatest growth of psychrophilic (spoilage) bacteria. Psychrophilic growth was reduced by frozen, $O_2$, and gas mixture methods with the mixture having the greatest reduction. Freezing, followed by storage in MAP gas mixture, $O_2$, and chill pack parts, caused the greatest reduction of aerobes through 14d. These data suggest that $O_2$ may be a preferred MAP enviroment because it actually reduced *Campylobacter* detection and retarted both psychrophile and aerobe growth during storage.

**Key Words:** *Campylobacter*, Modified atmosphere packaging, Storage

**221 Application of Active Packaging Films to Inhibit *Salmonella* Typhimurium on Broiler Drumstick Skin.** B.W. Sheldon*[1] and P.L. Dawson[2], [1]*North Carolina State University, Raleigh, NC/USA,* [2]*Clemson University, Clemson, SC/USA*.

The incorporation of bacterial inhibitors in biodegradable primary packaging films that are applied to fresh poultry products has the advantage of not only providing a hurdle for controlling pathogenic organisms at the processing plant but also throughout the entire marketing and distribution cold chain. The objective of this study was to develop and characterize the inhibitory activity of casted corn zein and heat-pressed wheat gluten packaging films containing varying combinations and concentrations of nisin, lauric acid, citric acid, and Tween 80 on inactivating a nalidixic acid-resistant strain of *Salmonella* Typhimurium on broiler drumstick skin. Following application to the skin and subsequent refrigeration, triplicate skin samples were taken at 42, 88, and 168 hours and the population of surviving *S.* Typhimurium cells estimated following a skin rinse and surface plating technique on BHI agar supplemented with 800 ppm nalidixic acid (37C, 48h). In comparison to control samples that were overlaid with films lacking any inhibitors, a significant reduction in the *S.* Typhimurium populations was detected in the films containing the inhibitors. The maximum inhibition detected was 1.23 (168 h) and 2.17 logs (44 h) for the corn zein and wheat gluten films, respectively. Those films containing multiple inhibitors such as nisin and lauric acid or nisin, lauric acid, citric acid, and Tween 80 produced the greatest inhibition. Reduction of microbial pathogens and spoilage microorganisms on fresh poultry products by safe and naturally occurring antimicrobials (i.e., bacteriocins and organic acids), achieved in a practical and economical way such as by packaging films, could contribute to a significant decrease in the incidence of human disease and the attendant costs. Furthermore, these active package delivery systems could also be utilized at the retail level to further assure the safety and quality of poultry products throughout retail marketing.

**Key Words:** Inhibitory Packaging, Nisin, *Salmonella* Typhimurium

**222 Effect of electron beam irradiation on poultry meat safety and quality.** S. J. Lewis*, A. Velásquez, S. L. Cuppett, and S. R. McKee, *University of Nebraska-Lincoln Lincoln, NE*.

FDA approved the use of irradiation for the control of salmonellae in poultry in 1990. Doses of 1.5 to 3.0 KGy in raw packaged poultry were established as guidelines in 1992. The purpose of this study was to determine whether electron beam irradiation doses of 1.0 and 1.8 KGy could eliminate bacteria in boneless, skinless chicken breasts. Microbial testing was done in triplicate with each treatment consisting of 10 samples. Four breast fillets in a covered/polystyrene tray constituted one sample. Results show that the average populations for coliforms, generic *E. coli*, and psychrotrophs were 11.0, 11.6, and 21.4 CFUs/ml, respectively, in the control samples. However, no populations were detected after the samples were irradiated at a dose of 1.0 or 1.8 KGy. An average level of 254.8 CFUs/ml was detected for aerobic bacteria in the control samples. Irradiation doses of 1.0 and 1.8 KGy reduced the levels to 1.3 and 0.4 CFUs/ml, respectively. Irradiation also rendered the breast fillets free of *Salmonella* and *Campylobacter*. Consumer taste panels were also conducted using a 9-point Hedonic scale to evaluate quality parameters of irradiated poultry. Three sets of each treatment group were randomly selected, individually packaged, and stored for 0, 14, and 28 days at -$4^\circ$C. Results indicated that the irradiated samples stored for 28 days were less appealing with increased drying and a decrease in the texture, flavor, and overall acceptability. Degree of oxidation was also tested in the breast fillets using TBAR analysis. Within each storage period, TBAR values increased as the level of irradiation increased. In addition, as storage time increased, the TBAR values also increased. Results also indicated that the irradiated samples had higher "a" values, indicating they were "pinker" in color when compared to the controls. In this study, irradiation of the breast fillets proved to be effective in the elimination of bacteria with an improvement in the breast fillet color, but quality of irradiated samples decreased with increasing storage time.

**Key Words:** irradiation, electron beam, quality of poultry meat

**223 Consumer poultry preparation habits and opinions concerning food safety, irradiation, and hormones in El Paso, TX and Las Cruces, NM.** K. G. Maciorowski*[1], S. G. Birkhold[2], and S. C. Ricke[2], [1]*Delaware State University,* [2]*Texas A&M University*.

One hundred and fifty supermarket shoppers were surveyed at random in El Paso, TX and Las Cruces, NM to determine poultry preparation habits and opinions concerning food safety, irradiation, and hormones. The respondents were generally older than 26 and 60% were female. The respondents were mostly either Hispanic (70%) or Caucasian (21%), and the majority (68%) possessed a high school education or less. Consumers believed that either pork (26%) or poultry (21%) was the most dangerous meat, with 27% citing no difference. A majority (57%) of consumers believed that bacterial issues were paramount for poultry, but 67% did not use a meat thermometer. Thermometers were most often used for whole birds (11%) or during holidays (12%). Poultry was generally frozen (48%) and thawed in a refrigerator (41%) before use. Television (29%) and family (20%) were most often cited as the most influential source of food safety information. Fifty-five percent of respondents claimed to have had foodborne illness, with either bacteria (17%) or spoiled food (13%) thought to be the culprit. Thirty percent would eat irradiated poultry, while 66% believed that hormones are used in poultry production. Educational programs could be best targeted via television, or by family nutrition counseling.

**Key Words:** Consumer, Survey, Meat Preparation

**224 Egg production and quality response of commercial laying hens molted with alfalfa diets.** K Medvedev*[1], C Woodward[1], X Li[1], L Kubena[2], D Nisbet[2], and S Ricke[1], [1]*Texas A&M University, Department of Poultry Science,* [2]*USDA-ARS, Food and Feed Safety Unit.*

Molting is a process that is used throughout the commercial egg industry to extend production in older laying hens. Common industry practices usually involve the removal of feed for a period of several days. It has been shown that molting by feed deprivation can cause a higher risk of *Salmonella* contamination in eggs. This coupled with the increasing awareness of molting practices by consumers has led to the need for alternative molting procedures. One such alternative is feeding alfalfa as an insoluble fiber source during molt. In this study, hen egg production and several quality factors were evaluated in hens that were feed deprived or fed alfalfa meal or pellets for a period of nine days. Hens were kept on a 8h:16h (light:dark) lighting program during the molting period. After the molting period, all hens were placed on layer ration *ad libitum* and a 16h:8h lighting program. Factors investigated include: date of reentry into production, air cell size, egg length, egg weight, egg circumference, albumin height, and yolk height. Post molt egg production in alfalfa pellet (61.24%) and alfalfa meal (55.14%) was shown to be significantly higher ($p \leq 0.05$) than feed deprivation (54.38%). All other quality measurements were consistent across all molting treatments in this study. This data suggests that birds molted using an alfalfa diet will produce eggs in comparable quality and number to birds molted by feed deprivation.

**Key Words:** Alfalfa, Egg production, Molt

**225 Conjugated Linoleic Acid Alters Egg Yolk Fatty Acid Composition and Volatile Compounds in Raw, Cooked and Irradiated Eggs.** Gita Cherian*[1], Troy B. Holsonbake[1], Mary P. Goeger[1], and Dong U. Ahn[2], [1]*Department of Animal Sciences, Oregon State University,* [2]*Department of Animal Science, Iowa State University.*

The effect of dietary conjugated linoleic acid (CLA) along with n-3 polyunsaturated fatty acid (n-3 PUFA) on yolk fatty acid composition and volatile compounds in raw (R), hard boiled (HB) or hard boiled eggs irradiated (HBI) at 2.5 kGy were investigated. Single Comb White Leghorn laying hens (n = 40) were randomly assigned to four experimental diets containing 0, 0.5, 1.0, or 2.0% CLA. Menhaden oil was used as the source of n-3 PUFA. Eggs collected after six weeks of feeding were analyzed for fatty acids (n = 6) and volatile compounds (n = 4). The content of C22:6 n-3 was reduced ($P < 0.05$) in eggs from hens fed high CLA diet. The contents of cis-9 trans-11 CLA and trans-10 cis-12 CLA in the egg yolk were 3.2 and 1.6%, respectively, for 2.0% CLA diet, and 0.9 and 0.35%, respectively, for 0.5% CLA diet ($P < 0.05$). Total volatiles were reduced in R eggs from 1.0 and 2.0% CLA diets. 2-Propanone, hexane and methyl cyclopentane were the major volatiles in R eggs and were reduced by dietary CLA at 1.0% and 2% levels. Acetaldehyde, pentane, propanol, acetic acid methyl ester, acetic acid ethyl ester, propionic acid methyl ester, 2-methyl-methyl propionic acid, 2-propanone and octane were the major volatiles in HB eggs and was reduced by 2.0% CLA ($P < 0.05$). No difference was observed in the acetaldehyde, pentane, propanol, acetic acid ethyl ester, octane and total volatile content of HBI eggs ($P > 0.05$).

**Key Words:** Conjugated linoleic acid, Yolk fatty acids, Egg volatiles

**226 Effect of electrostatic application of MaxSpray on *Salmonella* Enteritidis attached to the surface of eggs.** S. M. Russell*[1], [1]*The University of Georgia.*

A study was conducted to evaluate the effect of MaxSpray (N-Alkyl dimethyl benzyl ammonium chloride) in combination with an electrostatic spraying system (ESS) on populations of *Salmonella* Enteritidis (SE) coated onto the surface of eggs. Forty eggs were washed and sanitized using a chlorine based sanitizer. The eggs were rinsed thoroughly in deionized water to remove any residual sanitizer. Eggs were submerged into 1% peptone broth containing actively multiplying SE . Thirty of the eggs were placed into a plastic egg flat in the ESS chamber. MaxSpray solution (3600ppm) was prepared using sterile deionized water and electrostatically sprayed onto the eggs using two-10s bursts every hour for 6 h. A total of approximately 800mL of MaxSpray solution was used. The remaining 10 control eggs were treated by electrostatically spraying them with tap water using the same procedure as for the MaxSpray. Three eggs were also evaluated after immersion into SE and drying to determine how many SE attached to the egg. After treatment, the contents of each egg were aseptically removed and each shell was placed into a neutralizing solution. One mL of this solution was then placed into 9 mL of brain heart infusion broth (BHI) and vortexed. One mL of this solution was then placed into Bactometer module wells in duplicate. Bacterial growth was monitored using the Bactometer Microbiological Monitoring System 128. Three replicate trials were conducted. Microbiological tests indicated that for the three replicate trials, the initial inocula averaged 185, 370, and 120 SE/mL, respectively. SE was recovered from all control eggs, which had an average impedance detection time (DT) of 8.8, 8.7, and 8.0 for unsprayed control eggs, respectively, and 9.8 h for controls sprayed with tap water. Results demonstrated that MaxSpray was able to completely eliminate all SE on 19/30 (63%), 28/30 (93%), and 24/30 (80%) eggs in trials 1, 2, and 3, respectively. For eggs that remained contaminated with SE, the average DT significantly increased from 9.8 for the controls to 10.6, 11.1, and 13.3 (MaxSpray treated) in trials 1, 2, and 3, respectively, indicating a significant decrease in the number of SE. Thus, MaxSpray, in combination with ESS, appears to be an effective means of eliminating SE from egg surfaces.

**Key Words:** *Salmonella* Enteritidis, MaxSpray, Electrostatic Spraying System

**227 Why the Haugh Unit is wrong.** F. G. Silversides*[1] and T. A. Scott[2], [1]*Agriculture and Agri-Food Canada, Charlottetown, Canada,* [2]*Agriculture and Agri-Food Canada, Agassiz, Canada.*

The Haugh Unit was developed in the 1930s as a means of measuring the quality of an egg by measuring the height of the inner thick albumen. The Haugh Unit formula converts the height to a log scale because albumen height declines in a logarithmic fashion with storage, it uses a scale between 0 and 100, and it adjusts the height for the weight of the egg. The difficulties are in adjusting the height for egg weight, and in using a measure of the height of the inner thick albumen as a measure of egg quality. Eggs from ISA-White and ISA-Brown hens between 25 and 59 wk of age were stored at room temperature for 1 to 7 d to produce a data set with known variation in the three most important determinants of albumen height. Age and storage had the expected effects on egg size, yolk, shell and albumen weights, and albumen height. Regressions of albumen height on egg weight calculated for groups of eggs separated by age of hen and storage period for each strain varied between -0.058 and 0.102 mm per gm egg wt. The Haugh Unit formula uses a fixed regression of 0.05 mm in albumen height per gm egg weight and in this sample of eggs would have introduced a bias into the measurement of egg quality. The use of the log scale in the Haugh Unit suggests that early researchers used albumen height as a measure of freshness, and it is clear that albumen height decreases with storage. The height of the inner thick albumen is associated with levels of the protein ovomucin, which is extremely viscous. However, only 1.5 to 3.5 % of the total protein in albumen is ovomucin and other proteins with good foaming properties make up much larger proportions of the albumen. It is not clear from the scientific literature that moderate differences in albumen height are associated with altered functional characteristics of the egg, suggesting that the most appropriate use of albumen height is to measure freshness. In this sample of eggs, storage, strain of hen, and age of the hen all affected albumen height, imposing a bias on the measure of freshness which was not seen for albumen pH. Measuring freshness of eggs by the height of the inner thick albumen introduces a bias against old hens and some strains of hen, and adjusting the albumen height by applying the Haugh Unit formula further confounds the problem.

**Key Words:** Egg quality, Albumen height, Haugh unit

**228 The effect of cryogenic cooling with carbon dioxide on the USDA grade and microbial load of shell eggs in the commercial setting.** L.A. Hughes*[1], K.E. Anderson[1], and P.A. Curtis[1], [1]*North Carolina State University.*

To determine the effects of cryogenic cooling on the USDA grade and microbial quality of shell eggs, a commercial scale prototype CO2 cooling unit was placed in a commercial processing facility. Shell eggs were processed using an 8400 Diamond Washer/Grader. Eggs were washed, candled, and sorted for size then passed through the cryogenic prototype cooler prior to packaging. Eggs were packaged automatically and palletized prior to storage in a walk-in cooler (7C). Two trials were conducted, 12 and-15 week periods, respectively. On a weekly basis 18 dozen

of eggs were selected for grading samples based on USDA random sample selection process. Physical quality of intact shell eggs was significantly improved using cryogenic cooling. The difference in the percentage of AA, A, and B eggs began to differentiating after approximately 5 weeks of storage. Eggs cooled cryogenically maintained a higher AA quality throughout the storage period. A random sample of eggs was also selected to evaluate the shell surface and interior content microbial level. The microbial counts of the content of the cryogenically cooled eggs were significantly higher ($p<0.0001$) compared to traditionally cooled eggs in trial one. It was determined that the cooler sanitation was lacking during the first trial. A cleaning and sanitation protocol was developed for the cooler then the trial was repeated. Internal microbial loads between the two treatments were not significantly different in trial two, after the improvements were made. External microbial counts were higher for cryogenically cooled eggs ($P<0.002$) in both trials. The increased internal microbial level of cryogenic cooled eggs in trial 1 was due to the lack of cleaning and sanitizing of the cryogenic cooler. The physical quality of the eggs was better in the cryogenically cooled group, with no difference in apparent microbial quality. These trials led to improvements in the design of the equipment, which have been made in the commercial unit. These improvements will facilitate cleaning the equipment, reduce the shell surface microbial load, and improve the physical quality of the eggs.

**Key Words:** Cryogenic cooling, Shell eggs, Microbial load

**229 Comparison of quality and functionality of traditionally and cryogenically cooled shell eggs.** K.C. McAvoy*[1], P.A. Curtis[1], K.M. Keener[1], K.E. Anderson[2], and D.E. Conner[3], [1]*Department of Food Science, North Carolina State University,* [2]*Department of Poultry Science, North Carolina State University,* [3]*Department of Poultry Science, Auburn Universtiy.*

Previous studies have found that cryogenic cooling of shell eggs results in, a lower Salmonella enteritidis level, a higher quality egg, and a longer shelf-life than traditional cooling. This research was designed to compare quality and functionality of traditionally cooled eggs to cryogenically cooled eggs from a commercial egg processing plant. Three replicate runs of each of the two treatments were processed to give a total of six treatment reps. Data for cooling curves was obtained by inserting temperature probes attached to data recorders into an egg from each treatment rep. Two hours after processing the cryogenically cooled eggs had reached 11.6°C while the traditionally cooled eggs were at 28°C. Eggs from both treatments were held in refrigerated storage (4°C) during the fifteen-week testing period. Functionality and quality tests conducted include: Haugh units, displacement and specific gravity measurements of angel food and sponge cakes, emulsion stability of mayonnaise, shell and vitelline membrane strength, pH, whipping height and overrun. Haugh unit values were measured every week; all other functional and quality tests were conducted tri-weekly. Data was analyzed using the General Linear Model (GLM) of SAS (1996). Means were separated using the least square method. Cryogenic cooling of shell eggs with carbon dioxide increased the percentage of AA quality eggs compared to traditional cooling. The traditionally cooled eggs dropped from Grade AA to Grade A approximately one week prior to those from the cryogenic treatment. The average Haugh unit values for the fifteen-week testing period were 69.8 and 67.6 for the cryogenically and traditionally cooled eggs, respectively. There were no statistical differences in functionality measurements between the two treatments. Cryogenic cooling of shell eggs with carbon dioxide gas is a viable option for improving safety and quality of shell eggs. This enhanced safety and quality should have significant economic benefit to egg producers.

**Key Words:** Cryogenic Cooling, Shell Eggs, Functionality

## Biotechnology, Animal Products, and the Food Industry

**230 Is DNA or protein from feed detected in livestock products?** Kevin Glenn*, *Chair, ABSTC Subcommittee on DNA Detection.*

With the advent of highly sensitive analytical technology such as polymerase chain reaction (PCR), the need for documentation regarding the potential for the detection of DNA and protein from biotech crops in meat, milk, and eggs (MME) is critical. This is not a concern over the safety of the transgenic DNA or protein in MME since the introduced proteins undergo rigorous review prior to approval, and the UN FAO and WHO, the U.S. FDA and the U.S. EPA have all stated that DNA in food, including transgenic DNA in biotech crops, is a safe, natural component of food. However, it is well recognized that significant logistical problems would be incurred for meat, poultry, egg, and milk processors if labeling and segregation of products from animals fed biotech crops could occur using new detection methods. The scientific studies that have attempted to detect transgenic DNA or protein in MME derived from animals fed biotech crops will be reviewed. To date, the scientific evidence clearly shows that the transgenic DNA and proteins cannot be detected in MME products and that these products are equivalent in every way to products from animals fed conventional feeds. In addition, new data will presented from studies in which DNA and protein were extracted from chicken breast samples from animals fed YieldGard® or conventional corn. PCR followed by Southern blot hybridization was used to analyze the DNA for the presence of specific fragments from the Bt cry1Ab gene and the gene encoding the corn protein ADP glucose pyrophosphorylase (sh-2). None of the extracted DNA samples was positive for cry1Ab or sh-2. The extracted DNA was shown to be of high quality and amendable to PCR amplification of the chicken ovalbumin gene. In addition, data from a new competitive immunoassay sensitive to both intact and partially digested Cry1Ab protein will be presented, showing that this transgenic protein or immunoreactive fragments of the protein cannot be detected in the breast samples from chickens fed YieldGard® grain.

**Key Words:** Polymerase Chain Reaction, Transgenic DNA, YieldGard®

**231 Preventing food allergy - The impact of biotechnology.** James D. Astwood*, *Monsanto Company, St. Louis, MO.*

People who suffer from food allergies manage their condition by avoidance strategies such as diet eliminations and careful examination of ingredient labels. Unexpected exposures and resulting adverse reactions to food allergens represent the main challenge in food atopy. Unlike hay fever and respiratory allergies, immunotherapy has achieved only limited success because of the potency of food allergens - i.e., immunotherapy with food allergens can often trigger serious side effects, including anaphylaxis. Biotechnology has had a positive influence on the science of food allergy by facilitating the discovery and characterization of allergens using recombinant DNA methods. Today, it is generally accepted that most major allergens have been identified and described. Subsequently, biotechnology has enabled the development of diagnostics based on recombinant allergens and more recently has been used to engineer potentially safer immunotherapeutic versions of food allergens - the creation of de-allergenized variants. This will allow safer immunotherapies since the de-allergenized variants of food allergens should produce fewer, if any, side effects. In addition, DNA vaccines based on these variants are being tested presently, with a view of providing long-lasting immunotherapeutic options for food allergy patients. Biotechnology is also providing prophylactic options through the development of hypoallergenic foods which have either been engineered to contain fewer endogenous allergens, or have been modified by the presence of proteins like theoredoxin, to render endogenous food allergens less potent and less allergenic. Hypoallergenic foods could reduce the incidence of new food allergies on a global basis.

**Key Words:** Biotechnology , Allergy, Food

**232 The risks of going non-biotech.** Thomas P. Redick*, *Law Offices of Thomas P. Redick, Del Mar, CA.*

Many companies see product lines that are free from modern biotechnology (non-biotech) as necessary to satisfy consumers who may want "non-GMO" foods, including meat, eggs and milk from animals fed non-GMO feed. Before making this leap, however, companies should analyze