Evaluation of production, quality parameters, and sensory attributes of eggs from Hy-line Brown layers fed soybean and soybean-free diets using a caged and cage-free rearing system. 
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The objectives of this study were to (1) evaluate egg quality parameters, and (2) conduct scrambled and hard cooked sensory tests of eggs from Hy-line Brown commercial layers fed soybean and soybean-free diets using cage and cage-free rearing systems. A total of 246 layers, 30 wk old, were divided into 2 groups housed individually in either wire cages (120 hens) or grouped in a cage free system (126 hens) with open access to the ambient environment. The cage system consisted of 6 replicates/treatment of 10 hens/rep, and the cage free system consisted of 3 replicates/treatment of 21 hens/rep. Diets were formulated based on the nutrient requirements suggested by the Hy-line management guide for those hens. Eggs were collected daily and egg weight (g) was recorded weekly. Egg quality data was collected at 2-wk intervals during the study to evaluate albumen height (µm), shell thickness, breaking strength, and Haugh unit. Scrambled and hard cooked egg tests were conducted to evaluate overall like or dislike of flavor, texture, odor, and color using the 9-point hedonic scale test. Samples were placed in separate weigh boats labeled with 3 digit codes to avoid visual bias. These codes were used to evaluate the effect of each treatment on egg quality. Results demonstrated no difference in egg production in both systems except in the first month; the soybean diet had significantly higher egg production than the soybean-free diet. Egg weight was significantly higher for the soybean diet in the cage facility throughout the study while for the cage-free system egg weight was only higher during the first 2 mo on the soybean diet. No significant differences were observed in egg quality parameters between diets in both rearing facilities. For the sensory evaluation tests, results indicated that there was no significant difference between diets for either rearing system.

Key Words: brown egg, sensory, soybean, laying hen, cage free

Effects of reduced digestible lysine density on myopathies of the Pectoralis major muscles in broiler chickens at 46 d of age.
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Quantitative control of nutrient intake may decrease the incidence of wooden breast (WB) and white striping (WS) with some impairment of live performance. An experiment was conducted to determine if a similar reduction in myopathies might be obtained qualitatively by reducing digestible lysine (dLys) density in the diet. A total of 63 pens (25 birds/pen) were placed into 5 treatment groups (0, 0.25, 0.5, 1, and 2% dLys). Diets were formulated based on the nutrient requirements suggested by the Hy-line management guide for laying hens. Eggs were collected daily and egg weight (g) was recorded weekly. Egg quality data was collected at 2-wk intervals during the study to evaluate albumen height (µm), shell thickness, breaking strength, and Haugh unit. Scrambled and hard cooked egg tests were conducted to evaluate overall like or dislike of flavor, texture, odor, and color using the 9-point hedonic scale test. Samples were placed in separate weigh boats labeled with 3 digit codes to avoid visual bias. These codes were used to evaluate the effect of each treatment on egg quality. Results demonstrated no difference in egg production in both systems except in the first month; the soybean diet had significantly higher egg production than the soybean-free diet. Egg weight was significantly higher for the soybean diet in the cage facility throughout the study while for the cage-free system egg weight was only higher during the first 2 mo on the soybean diet. No significant differences were observed in egg quality parameters between diets in both rearing facilities. For the sensory evaluation tests, results indicated that there was no significant difference between diets for either rearing system.

Key Words: brown egg, sensory, soybean, laying hen, cage free

Carvacrol reduces both Campylobacter and aerobic counts on broiler chicken skin. Sandip Shrestha*1, Basanta R. Wagle1, Komala Arsi1, Abhinav Upadhyay1, Pam J. Bloure1, Annie M. Donoghue1, Kumar Venkitaranayan2, and Dan J. Donoghue1,1University of Arkansas, Fayetteville, AR, 2University of Connecticut, Storrs, CT, 3Poultry Production and Product Safety Research Unit, ARS, USDA, Fayetteville, AR.

Carvacrol is the leading cause of human foodborne disease worldwide and epidemiological investigations suggest that human infections are often associated with cross-contamination of raw chicken meat with other food products. Many strategies are currently being investigated to reduce Campylobacter counts on commercially produced chicken and chicken products. Unfortunately, most of the strategies have been met with limited success. Use of plant-derived compounds with antimicrobial activity, such as carvacrol (CR), a component of wild oregano oil, could be an effective strategy to reduce Campylobacter counts in post-harvest poultry. Preliminary studies with CR demonstrated anti-Campylobacter activity, in vitro. In this study, we evaluated the efficacy of CR against Campylobacter on chicken thigh skin. A total of 2 trials were conducted. For each trial, 75 skin samples (4 × 4 cm each) were randomly allocated into 5 treatment groups (0, 0.25, 0.5, 1, and 2% CR). Skin samples were inoculated with a cocktail of 4 wild strains of C. jejuni (~8 log10 cfu/skin) and then allowed to adhere for 30 min. Inoculated samples were dipped in respective wash treatment solution for 1 min, allowed to drip dry for 2 min and were processed at 0, 8, and 24 h post-treatment (n = 5/time point/treatment group) for enumeration of Campylobacter and aerobic bacterial counts. The data were analyzed by ANOVA using GLM procedure of SAS 9.3 and expressed as LSMEANS with differences considered significant at P < 0.05. Aerobic counts were reduced for the 0.5% CR dose at 0 and 24 h in trial 1 and at 0, 8 and 24 h in trial 2. The 1 and 2% CR doses consistently reduced aerobic counts in both trials (up to 2 log10 cfu/skin) and then allowed to adhere for 30 min. Inoculated samples were dipped in respective wash treatment solution for 1 min, allowed to drip dry for 2 min and were processed at 0, 8, and 24 h post-treatment (n = 5/time point/treatment group) for enumeration of Campylobacter and aerobic bacterial counts. The data were analyzed by ANOVA using GLM procedure of SAS 9.3 and expressed as LSMEANS with differences considered significant at P < 0.05. Aerobic counts were reduced for the 0.5% CR dose at 0 and 24 h in trial 1 and at 0, 8 and 24 h in trial 2. The 1 and 2% CR doses consistently reduced Campylobacter counts (up to 4 log10 cfu/skin) in both trials. These results support the potential use of CR to reduce both aerobic and Campylobacter counts on postharvest chicken products.

Key Words: Campylobacter jejuni, carvacrol, chicken skin, postharvest
Cook loss percent (CL) is a quality measure used to determine the water holding capacity of meat. Current methods of determining cook loss in breast meat are time consuming and require large sample sizes. The objective of this study was to determine if modification of the oven method could have statistical similarities to the current method. Broiler butterflies where obtained from a commercial supplier and split in half (n = 30). The weight and pH values of labeled left and right fillets were individually recorded to account for possible variation from the muscle tissue. The left fillets (LF) was used for the oven method (OM) and grouped in 100g increments before placing them in aluminum pans with a pre-oiled metal grill. Thermocouples were placed on the cranial side of 2 breast fillets per pan, to record final internal temperature. Pans were covered with aluminum foil and placed in a gas convection oven at 177°C until the internal temperature of the meat reached 73°C. The pans were allowed to cool for 15 min before re-weighing the fillets. The right fillet (RF) was used for the modified method (MOD) by duplicate portioning the cranial section 61 × 52 × 13-mm rectangles and split into 2 sections before cooking using the OM. A 2-sample t-test using α = 0.05 comparing both cook loss methods was performed. Variance was determined with an F-test using α = 0.05. The weight and pH means of the cooking method. The observed variance between the 2 cooking methods did not affect (P = 0.2540) the possible differences observed in the means. The OM CL mean (22.63 ± 2.23) was not different (P = 0.0938; 1-β = 0.418) from the MOD CL mean (20.84 ± 3.14). However, we observed that cooking times from the MOD (40 min) were reduced (P < 0.05) cook loss (22.74) when compared with treatments B (9.27) but lower (P < 0.05) than A (10.35) and D (10.07). Control had the lowest (P < 0.05) final retention (64.42) when compared with treatments B (73.53), C (73.68) and D (73.60) which were not different from each other. A higher (P < 0.05) shear force was found in the control (2.83), whereas B (1.65), C (1.74) and D (1.73) had similar (P > 0.05) shear values. All the treatments had similar (P > 0.05) sensory scores in appearance, flavor, tenderness and overall liking. Juiciness scores of B (6.76), C (6.84) and D (6.90) were similar (P > 0.05) but higher (P < 0.05) than the control (5.33). In conclusion, addition of RS at 1.5% level in marinated chicken breast had similar or better functionality compared with CSA and CSB at 1.5% level.

Key Words: rice starch, corn starch, marinate, breast

Using peak counts in shear data to detect woody breast in cooked broiler fillets. Xiao Sun*,1,2, Famous L. Yang2, Jessica L. Solo2, Barbara A. Mallmann2, Craig N. Coon2, and Casey M. Owens2, 3College of Engineering, Nanjing Agricultural University, Nanjing, Jiangsu, China, 2Poultry Science Department, University of Arkansas, Fayetteville, AR.

Woody breast (WB) has been a major quality issue recently in the poultry industry which is observed as a distinct hardness of breast fillet. This study was conducted to determine the shear properties using Meullenet-Owens razor shear (MORS) and Blunt-MORS (BMORS) on cooked fillets with varying degrees of WB that were stored fresh (4°C) or frozen (−20°C). Additionally, a new method of peak counting on MORS and BMORS data was used to identify WB categories by assessing inner texture features. Whole breast fillets scored in 3 woody categories (NORM, MOD, and SEV, n = 20 reps/group) were collected from 8wk old broilers deboned at 2h postmortem. Left fillets were cooked to an internal temperature to 76°C at 24h postmortem. Right fillets were vacuum packed, stored frozen for 3wk, thawed overnight at a 4°C, and then cooked to 76°C, cook loss was determined. Fillets were sheared in 4 locations in the cranial region with MORS and BMORS probes using the TA.XTPlus Texture Analyzer (Texture Technologies Corp., Hamilton, MA/Stable Micro Systems, Godalming, UK). The energy (MORS, BMORS), peak counts from shear curve of MORS (PC-MORS) and BMORS (PC-BMORS) were recorded on each fillet. Cook loss was higher (P < 0.05) in SEV fillets than MOD and NORM which were similar (P > 0.05) in either fresh or frozen fillets. There were no differences (P > 0.05) in MORSE due to WB categories, but BMORSE was higher (P < 0.05) in SEV fillets compared with MOD and NORM fresh fillets. SEV fillets had higher (P < 0.05) PC-MORS than MOD and NORM fillets whereas PC-BMORS increased (P < 0.05) as severity of WB increased in the 2 storage methods. MORSE and BMORSE of most WB categories were higher (P < 0.05) in frozen fillets than fresh except BMORSE of SEV fillets, which were not affected by storage method. The results indicate that SEV WB in both storage methods negatively affect cook loss and shear properties (excluding MORSE). The new method of peak counting using the TA.XTPlus was useful in distinguishing among WB categories. The PC-BMORS was able to detect differences between each category and was not affected by storage method of fresh or frozen.

Key Words: woody breast, storage method, MORS, BMORS, peak counts

Functionality of a native rice starch compared to modified corn starches in marinated chicken breast meat. Jiyang Fang*, Gerardo Casco, and Christine Z. Alvarado, Department of Poultry Science, Texas A&M University, College Station, TX.

The objective of this study was to evaluate the effect of a native rice starch (RS) compared with other 2 modified corn starches (CSA, CSB) on yield, texture, and sensory of marinated chicken breast. A total of 300 chicken breast fillets (5 treatments, 2 replications) were injected then tumbled with 20% brine resulting in 0.48% STPP and 0.55% salt (Control) or as treatments with added starches (1.0% RS (A), 1.5% RS (B), 1.5% CSA (C) or 1.5% CSB (D)). Samples were cooked, vacuum packaged, and blast frozen for 1 wk, thawed and reheated until internal temperature reached 74°C. Injection yield (%), tumbled yield (%), cook loss (%), thaw loss (%), reheat loss (%), and final retention (%) were calculated, and Warner-Bratzler shear force (N) (n = 150) were determined. A consumer sensory panel (n = 51) was conducted for reheated samples using a 9-point hedonic scale. All data were analyzed by SAS GLM with Duncan’s multiple range test using P < 0.05. Control had the highest (P < 0.05) cook loss (22.74) when compared with treatments B (14.87) and D (14.74) which had lower cook loss (P < 0.05) when compared with A (16.68) and C (16.47). Control (14.10) also had the highest (P < 0.05) reheat loss when compared with C (8.15) which was similar (P > 0.05) to B (9.27) but lower (P < 0.05) than A (10.35) and D (10.07). Control had the lowest (P < 0.05) final retention (64.42) when compared with treatments B (73.53), C (73.68) and D (73.60) which were not different from each other. A higher (P < 0.05) shear force was found in the control (2.83), whereas B (1.65), C (1.74) and D (1.73) had similar (P > 0.05) shear values. All the treatments had similar (P > 0.05) sensory scores in appearance, flavor, tenderness and overall liking. Juiciness scores of B (6.76), C (6.84) and D (6.90) were similar (P > 0.05) but higher (P < 0.05) than the control (5.33). In conclusion, addition of RS at 1.5% level in marinated chicken breast had similar or better functionality compared with CSA and CSB at 1.5% level.

Key Words: cook loss, breast, water holding capacity
Woody breast (WB) is a recent meat quality concern affecting breast fillets of fast growing broilers by palpable hardness in the *pectoralis major* muscle. Incidence of severity generally increases with age, but the effects of age on meat quality of WB is not known. A study was conducted to determine effect of age on meat quality factors associated with varying degrees of woody condition. Male broilers were commercially processed at 45 d (n = 80), 63 d (n = 50), and 70 d (n = 41) of age and scored using categories: normal (NORM) and severe (SEV) woody breast. Compression force (CF) was assessed on raw fillets and sarcomere length (SL) analysis of each sample was performed. Fillets were cooked to 76°C, cook loss (CL) was calculated, and MORS energy (MORSE) and BMORS energy (BMORSE) were measured using the TA.XTPlus Texture Analyzer (Texturization Technologies Corp., Hamilton, MA/Stable Micro Systems, Godalming, UK). Additionally, peaks of the shear curves were counted (PC-MORS and PC-BMORS) and averaged per fillet. CF, SL, and CL were all higher (P < 0.05) in SEV fillets than NORM fillets. For NORM fillets, age did not affect CF, but CF increased with age in SEV fillets (70 > 45 d, P < 0.05). CL was higher (P < 0.05) at 63 d than at 45 d. SL generally increased (P < 0.05) with age, but SEV fillets had higher (P < 0.05) SL than NORM fillets. MORSE and BMORSE were higher (P < 0.05) at 70 and 63 d compared with 45 d, and these shear values were lower (P < 0.05) for SEV fillets than NORM fillets at 45 d only. SEV fillets had greater (P < 0.05) PC-MORS and PC-BMORS compared with NORM at all ages, and these peak counts were greater (P < 0.05) at 70 and 63 d compared with 45 d. Results suggest that WB category and age both have effects on meat quality; however, in most cases, age affects WB categories similarly. Results also indicate that compression force (raw fillets) and peak counts (cooked fillets) using the TA.XTPlus are able to distinguish between normal fillets and severe woody breast and may be better to assess woody breast than shear energy. These measures may assess different aspects of texture than traditional tenderness/toughness attributes.

**Key Words:** woody breast, age, meat quality

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**154 Descriptive sensory and texture profile characterization of marinated woody breast meat.** Maria E. Aguillar1,3, Casey M. Owens1, Rhonda K. Miller2, and Christine Z. Alvarado1, 1Department of Nutrition and Food Science, Texas A&M University, College Station, TX; 2Department of Poultry Science, University of Arkansas, Fayetteville, AR; 3Department of Animal Science, Texas A&M University, College Station, TX; 4Department of Poultry Science, Texas A&M University, College Station, TX.

The broiler industry has a variable meat texture issue known as woody breast (WB). This research compares quality attributes of normal and severe WB in 2 experiments. Experiment 1 objective was to develop and validate a descriptive texture attribute panel with 6 trained panelists using a 16-point scale (0 = none, 15 = extremely intense). Sixty-four normal and severe WB in 2 replications were obtained from a commercial facility, injected with 12% brine (0.48 STPP, 0.55% NaCl) and 20 min drip loss was determined. Fillet color (L*), and pH were determined before being vacuum packaged, stored (29°C, <1 wk), and thawed (4C, 24h). Fillets were cooked (73°C) on a gas grill or in foil covered pans in a convection oven and cook loss was determined. Panelists samples from the cranial portion of the fillet were cut into 3 pieces (2.54 cm × 2.54 cm). The data were analyzed (SAS) using GLM and LS-MEANS with P < 0.05 to determine significance. L* and pH were higher for WB than normal fillets (P < 0.05). After marination, WB had higher 20 min drip loss and higher cook loss (20.0, 16.8) than normal fillets (P < 0.05). No significant differences were found between the cooking methods. Sensory panel descriptors of hardness (4.56, 4.97), springiness (3.87, 4.32), cohesiveness (4.96, 5.31), denseness (4.77, 5.38), crunchiness (1.88, 2.78), fracturability (2.83, 3.23), fibrous (2.01, 3.19) and chewiness (1.62, 2.41) were higher for WB than normal fillets (P < 0.05). In Experiment 2, both oven and grill cooking methods were used to evaluate texture profile analysis (TPA, 3 samples, 4 cm × 2 cm) to determine differences between normal and WB either stored fresh (<48 h postmortem, 4°C) or frozen (<1 mo, −29°C). The data were analyzed (SAS) using GLM and LS-MEANS and P < 0.05. TPA for fresh oven cooked samples were higher than grilled samples (P < 0.05). TPA descriptors of hardness, cohesiveness, springiness, gumminess and chewiness were higher for WB than normal fillets (P < 0.05). When comparing fresh and frozen storage methods, only cohesiveness was significantly higher in WB than normal. Therefore, marinated severe WB have significant texture differences when compared with normal breast.

**Key Words:** texture profile analysis, woody breast, marination, sensory

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**153 Wooden breast muscle myopathies are reduced with increased dietary potassium and available phosphorous.** Matthew L. Livingston1, Chelsea D. Lando2, Harold J. Barnes2, and John T. Brake1, 1Prestage Department of Poultry Science, North Carolina State University, Raleigh, NC; 2Department of Population and Health Pathology, NCSU College of Veterinary Medicine, Raleigh, NC.

Dietary potassium (K) and phosphorous (P) levels in diets have decreased in recent years. Both of these ions are intimately involved in the elimination of hydrogen ions that are produced during rapid growth. It was hypothesized that the decrease in these dietary electrolytes was decreased in recent years. Dietary potassium (K) and phosphorus (P) levels in diets have significant texture differences when compared with normal breast. Carcass data and woody breast muscle scores (WBMS) were collected at 21, 35, 42, and 49 d. WBMS were determined by hand palpation using a 4-point (0-4) ordinal scale of measurement. Blood gas and chemistry were measured at 28, 42, and 49 d. HK produced better FCR at 35 d (1.52 vs 1.57 g:g), lower hemoglobin (6.83 vs 7.58 g/dL) and packed cell volume (20.1 vs 22.3%) at 28 d, reduced ionized blood calcium (1.42 vs 1.47 mmol/L) at 42 d, and lower partial pressure of blood CO2 (49.1 vs 54.7 mmHg) at 42 d relative to broilers fed LK (P < 0.05). Fixed AvP diets improved FCR (1.51 vs 1.55 g:g) at 28 d, greater percentage breast meat (28.85 vs 27.58%) and water pickup (2.72 vs 1.42%) at 35 d, as well as reduced WBMS (2.88 vs 3.69) at 42 d (P < 0.05). Increased dietary levels of K and AvP ameliorated WBMS and improved live and carcass performance of broiler chickens.

**Key Words:** wooden breast, broiler, electrolyte, myopathies