
The objective of this study was to compare the welfare and the external and internal quality of eggs from hens housed in cages or pens. The hen welfare was evaluated using 2 traditional (tonic immobility duration and heterophil to lymphocyte ratio) and 3 novel indicators (incidence of eggs with pink shells, brown spotted shells, or internal inclusions). The external egg quality was analyzed for specific gravity, incidence of cracked and dirty eggs, shell color, egg weight, and shape index, whereas the internal egg quality was analyzed for yolk color and Haugh units. Cages were half-way between conventional and enriched cages. Four different breeds (white-, tinted-, brown-, and dark brown-shell egg layers), and a total of 240 hens and 760 fresh eggs were sampled. A repeated measures ANOVA was used. Tonic immobility duration, heterophil to lymphocyte ratio, and percentages were transformed to logarithm, square root, and arcsin square root, respectively. There was no significant housing system by breed interaction for any welfare indicator and incidence of dirty eggs. The effect of the housing system on tonic immobility duration and incidence of brown spotted shells was significant (P < 0.05), with values being shorter (152 vs. 221 ± 17 s) and higher (23 vs. 10 ± 1%) in hens housed in cages. Interaction was significant for specific gravity, incidence of cracked eggs, shell color, yolk color, Haugh units, egg weight, and shape index. Eggs from hens housed in cages had significant darker shell color in all breeds, higher Haugh units in 3 breeds, higher specific gravity in 2 breeds, and lower incidence of cracks and egg weight, and higher egg shape in one breed. Mortality percentage was similar in both systems, being lower than 3%. In conclusion, results for hen welfare were not consistent across welfare indicators, and cages were better than pens for shell color, shell strength, and Haugh units, although differences were not consistent across breeds.

Key Words: osteoporosis, bone mineralization, perch, keel fracture, muscle deposition

P257  The effect of perch availability during pullet rearing and egg laying on musculoskeletal health of caged White Leghorn hens. P. Y. Hester*, S. A. Enneking1, B. K. Haley1, H. W. Cheng1, M. E. Einstein1, and D. A. Rubin1, Purdue University, West Lafayette, IN, 2USDA-ARS, West Lafayette, IN, 3Illinois State University, Normal.

A major skeletal problem of conventionally caged hens is increased susceptibility to osteoporosis mainly due to lack of exercise. Osteoporosis is characterized by a progressive decrease in mineralized structural bone. Whereas considerable attention has been given to enriching laying cages, little research has been conducted on providing caged pullets with furnishings, in particular perches. The objective of the current study was to determine if metal perches during all or part of the life cycle on physiological homeostasis in caged White Leghorns.

Hy-line W36 chickens with or without perch access during pullet rearing were randomly assigned to 1 of 4 treatments with 9 replicates per treatment at 17 wk of age. Treatment 1 chickens never had access to perches during their life cycle. Treatment 2 chickens had access to perches only during the egg laying phase (17 to 71 wk of age), and treatment 3 hens always had access to perches during their entire life cycle (hatch to 71wk of age). Each laying cage provided 439 cm², 16.9 cm, and 8.4 cm of floor space, perch space, and feeder space per hen, respectively. Plasma catecholamines [epinephrine (EP), norepinephrine (NE), and dopamine (DA)], corticosterone (CORT), blood serotonin, tryptophan, and right adrenal weights were measured at 71 wk of age. The design of the experiment was completely randomized using a 2 x 2 factorial arrangement in which the presence or absence of the perches within the pullet or laying cages were the main plots. The mixed model procedure of the SAS Institute was used to analyze the data. Levels of EP, NE, DA, CORT, serotonin, and tryptophan, as well as EP/NE ratios and adrenal weights of 71-wk-old hens were not affected by perch access during the laying phase or by prior experience to perches as pullets. Results suggest that the installation of perches in conventional cages does not affect the stress response in White Leghorn hens.

Key Words: perch, catecholamine, serotonin, corticosterone, chicken

P258  The effect of perch access during pullet rearing and egg laying on physiological parameters of caged White Leghorn hens. F. F. Yan*, P. Y. Hester1, S. A. Enneking1, and H. W. Cheng2, Purdue University, West Lafayette, IN, 2USDA-ARS, West Lafayette, IN.

Egg laying strains of chickens have a strong motivation to perch. Perch use by chickens in pullet cages has received little attention. The objective of this study was to determine the effect of perch access during all or part of life cycle on physiological homeostasis in caged White Leghorns.

Hy-line W36 chickens with or without perch access during pullet rearing were randomly assigned to 1 of 4 treatments with 9 replicates per treatment at 17 wk of age. Treatment 1 chickens never had access to perches during their life cycle. Treatment 2 chickens had access to perches only during the pullet phase (hatch to 16.9 wk of age). Treatment 3 chickens had access to perches only during the egg laying phase (17 to 71 wk of age), and treatment 4 hens always had access to perches during their entire life cycle (hatch to 71wk of age). Each laying cage provided 439 cm², 16.9 cm, and 8.4 cm of floor space, perch space, and feeder space per hen, respectively. Plasma catecholamines [epinephrine (EP), norepinephrine (NE), and dopamine (DA)], corticosterone (CORT), blood serotonin, tryptophan, and right adrenal weights were measured at 71 wk of age. The design of the experiment was completely randomized using a 2 x 2 factorial arrangement in which the presence or absence of the perches within the pullet or laying cages were the main plots. The mixed model procedure of the SAS Institute was used to analyze the data. Levels of EP, NE, DA, CORT, serotonin, and tryptophan, as well as EP/NE ratios and adrenal weights of 71-wk-old hens were not affected by perch access during the laying phase or by prior experience to perches as pullets. These results suggest that installation of perches in conventional cages does not affect the stress response in White Leghorn hens.

Key Words: perch, catecholamine, serotonin, corticosterone, chicken

P259  Influence of perching on keel bone deformities in laying hens. P. Regmi* and D. M. Karcher, Michigan State University, East Lansing.

Perches are provided in modern hen housing systems for laying hens to fulfill their behavioral needs. However, higher incidences of keel bone deformities have been associated with the use of perches in the aviary and free-range housing systems. The aim of this study was to analyze the association of perching with the incidence of keel bone deformities in laying hens. Three hundred ISA White Shaver hens at 16 weeks of
age were housed in groups of 10 across 30 individual pens provided with a flat perch and an alighting rail in front of the nest box. At 18 weeks of age, each hen was marked with livestock marker for individual identification on the video. A total of 211 birds had behavioral data available from video recordings taken at 21, 24, 28, 32, and 37 weeks of age. Birds were observed the first 10 min following lights coming on to identify whether or not they used perch during the night. Each bird that was observed using perch consistently for 3 or more occasions was used for data analysis. Beginning at 37 weeks of age, birds were transferred to cages and palpated once a month for 3 mo for assessment of keel bone deformities. Keel was scored as ‘0’ or ‘1’ based on absence or presence of any kind of deformities (indentations, twists or fractures). After the third round of palpation, 40 birds were euthanized and the keel bone collected for the validation of palpation results. Chi-squared test of independence indicated a highly significant ($P < 0.0001$) association of perching behavior and the occurrence of keel deformities. The results suggest that perches can be highly influential in the development of keel bone deformities in laying hens.

**Key Words:** perch, laying hen, keel deformities, housing

**P260** Flight behavior and successful landings of laying hens housed in aviary systems with litter. S. L. Goodwin*1, M. M. Makagon2, J. Swanson1, and J. M. Siegfried1, 1Michigan State University, Lansing, 2Purdue University, West Lafayette, IN.

Considering the spatial availability differences in aviary systems compared with conventional systems, it is expected that laying hens have more room to perform natural behaviors in aviaries. With multiple levels, nest boxes, perches and litter in addition to the standard feeders and drinkers, these systems provide a variety of enrichments that allow hens to perform natural behaviors, such as flight. More space helps birds to work muscles and bones during flight. However, more flight space may not necessarily be more beneficial for hens, as we have anecdotally observed that many hens do not land on their feet. Using data from a commercial facility, this study focuses on landing success for each flight observed over an entire day (lights on to lights off) in 4 aviary sections on 2 separate dates. Flights that began and ended on litter had a success rate of 74.83% during mid-lay and a success rate of 87.3% during late-lay. Flights that originated on perches and ended on litter had a success rate of 83.5% for mid-lay and 86.36% for late-lay. No difference was found in the proportion of failed versus successful landings based on whether hens were flying from litter to litter or perch to litter ($C_2 = 6.4, P = 0.03$). Conversely, the proportion of crashes observed in hens at late lay was significantly higher than observed in hens at mid lay ($C_2 = 4.2, P = 0.039$). Also, a higher proportion of flights occurring in double aviary sections resulted in crashes compared with flights made in single aviary sections ($C_2 = 5.4, P = 0.02$). This study is a part of the Coalition for a Sustainable Egg Supply (CSES) project.

**Key Words:** laying hen, aviary, flight behavior, CSES

**P261** Behavioral study and plumage condition of laying hens housed in aviaries or conventional cages. A. Steiner*1, P. E. Eusebio-Balcazar1, M. Beck2, and S. Purdum1, 1University of Nebraska, Lincoln, 2Mississippi State University, Mississippi State.

The study of hen behavior is important to find ways to improve welfare and establish adequate management practices. Four hundred 1-d-old pullets, Lohmann Brown (B) and Bovan White (W) intermingled in equal numbers, were placed into 8 floor pens. At 5 wk, those pullets were moved to 8 aviary units (A) (Natura 60, Big Dutchman Inc.). Two hundred twenty-four 1-d-old caged pullets were placed in 56 cages (C) at 7 wk of age. Each “A” unit had 3 tiers and a litter area underneath and beyond the aviaries in which birds could move freely. A nest area was located in the top tier, and feeder troughs were placed in the middle and lower tier. Sixteen A hens and 16 C hens were randomly selected and identified by colored leg zip ties. Time budget was determined by focal sampling observing each hen for 5 min in the morning and in the afternoon at 21, 28, 37, and 45 wk. Budget consisted of drinking, eating, foraging, pecking other birds, pecking objects, perching, preening, sitting, standing, and walking times. Also, a sample of 112 A hens and 64 C hens were evaluated by a 4 point scoring system (1 = no coverage, 4 = good) to determine plumage condition for 6 body parts (neck, breast, wings, tails, and vent) at 46 wk. Data were analyzed as a factorial design with repeated measures. C hens spent more time standing ($P = 0.01$) compared with A hens of both strains. BC hens spent more time eating compared with BA hens (28.25 vs. 13.63%, $P = 0.05$). WA hens spent less time pecking other birds compared with WC hens (0.1 vs. 0.5%, $P = 0.08$) and BA hens spent less time pecking objects compared with BC hens (4.0 vs. 16.8%, $P = 0.007$). A similar effect on time spent pecking objects was observed for W hens at 25 and 45 wk ($P = 0.001$). AB ($P = 0.04$) and AW ($P = 0.11$) hens spent more time foraging in the afternoon. No differences were observed due to housing system or strain on the overall feathering score ($P > 0.05$); however, “A” hens had higher plumage damage in the backs, vents and necks compared with C hens ($P < 0.0001$). Thus, aviary housing reduced some undesirable behaviors, but had a detrimental effect on feather condition of some body parts.

**Key Words:** colony and aviary housing systems, laying hen, dust bathing, feather

**P262** The effectiveness of dust bathing substrates in enriched colony and aviary laying hen housing systems. R. A. Blatchford*1, J. A. Mencah1, M. A. De Luz1, J. M. Siegfried2, M. M. Makagon2, D. L. M. Campbell2, and J. C. Swanso1, 1University of California, Davis, 2Michigan State University, East Lansing.

Dust bathing behavior functions to reduce excess feather lipids, keeping feathers in good condition. Hens in non-cage systems have access to litter for dust bathing, while hens in enriched colony systems (EC) are provided an Astroturf pad sprinkled with feed. As part of the Coalition for a Sustainable Egg Supply Laying Hen Research project, we evaluated the use of wood shavings litter in an aviary (AV) and feed-sprinkled Astroturf in EC for dust bathing, as well as their effectiveness in reducing feather lipids, on a commercial farm. The open litter areas in 8 sections of the AV, and 18 EC, were videotaped during the morning (10:30–12:30), afternoon (15:00–17:00), and evening (19:30–21:30) when hens were 52 wk of age. Lipid content of the breast (n = 27) and (n = 26) feathers of hens in the EC and AV, as well as hens housed in enriched cages with no access to substrate (CC; control) at the same facility, was analyzed at 72 wk using Soxtec extraction. Hens in EC used the pad for 14% of all dust bathing bouts, but the rest of the bouts took place on the wire floor. In the AV, 0–34% (mean 7%) of hens in the open litter area dust bathed during the observations. Analysis of variance analysis showed that EC (17.2 ± 0.6 mg/g) and AV (17.7 ± 1.1 mg/g) hens had lower ($P < 0.001$) lipid levels on their breast feathers than CC hens (24.4 ± 1.2 mg/g). However, the lipid levels of the back feathers of the EC (19.4 ± 0.5 mg/g) and CC (21.6 ± 0.9 mg/g) hens were higher ($P < 0.001$) than those of AV hens (13.8 ± 0.8 mg/g). Although hens in EC dust bathed on the Astroturf pad at a relatively low rate, this was effective for reducing feather lipids on the breast, but less effective than dust bathing in litter in the AV for reducing feather lipids on the back.

**Key Words:** enriched colony, hen, dust bathing, aviary, feather lipid
P263  Is increased fear associated with feather pecking in commercial turkeys? C. N. Niewiadomski*, M. Erasmus, J. M. Siegfried, and J. Swanson, Michigan State University, East Lansing.

Feather pecking, a form of injurious pecking, is a problem in commercial turkeys. Previous research has shown different tendencies of chickens to develop feather pecking with some association between this behavior and a hen’s fear response. No research to date has examined the individual differences in feather pecking and fear responses among turkeys. This study evaluated whether a relationship exists between feather pecking and fear responses in turkeys. Commercial male turkeys were housed in groups of 5 to 6 in 8 pens from d 1 to 14 wk of age. Behavior was video-recorded at 8 wk and instantaneous scan samples of behavior were executed at 5-min intervals, identifying birds that feather pecked (PECK) and birds that did not (NPECK). Turkeys were also classified as targets of feather pecking (TAR) or not (NTAR). Three fear tests, tonic immobility (TI), novel object (NO), and open field (OF), were used to assess turkeys’ fear responses at 8 wk (n = 32). Differences in fear responses of PECK and NPECK and TAR and NTAR were evaluated using Fisher’s exact test. Results from OF and NO tests were not significantly different between turkeys of the various classifications. However, there was a trend toward significance between TI fear responses of NTAR and TAR birds (P = 0.057). Thus PECK birds were not distinct in their responses to TI, NO, and OF tests when compared with NPECK birds, demonstrating that the performance of feather pecking does not appear to be associated with fear responses in turkeys though being a target of feather pecking might be.

Key Words: feather pecking, fear, turkey, group housing


Ostriches are the largest living birds with only 2 toes on each of 2 long feet to support a heavy body mass. This special anatomical feature creates problems for transporting ostriches, different than for other livestock species. The main objective of our study was to develop and apply a holistic research model to improve ostrich welfare during pre-slaughter handling and transport, and to improve their product quality. Five information sources were considered in developing the welfare assessment model: (1) Production practices: We conducted a survey of ostrich producers in the USA and Canada to identify current production practices and potential welfare issues related to ostrich handling/transport; (2) Behavioral and physiological stress responses: Based on the identified potential welfare issues from the producers’ survey, we conducted 3 ostrich transport trials to study the behavioral and physiological responses of ostriches during handling/transport; (3) Product quality and safety: We measured site and severity of skin physical damages (e.g. bruises), and evaluated meat quality of slaughtered ostriches to identify the effects of handling/transport practices; (4) Public perception: Based on the results of our study, recommendations were made to educate consumers about the effects of different practices on ostrich welfare; and (5) Standards and guidelines: Ratite transport welfare standards from several countries were studied, considering available scientific knowledge, to improve the current ostrich transport guidelines. The model and actual experimental results will be presented in association with each component of the model. By applying the developed model we could identify potential welfare issues of the current ostrich transport practices. We found that pre-transport holding duration should be minimized; long distance transportation is detrimental to ostrich welfare with significant loss to producers; and the use of pre-transport nutrient supplementation can partially alleviate the effect of transportation stress in ostriches.

Key Words: handling, ostrich, research model, transport, welfare