Implications of maternal laying hens' feather-pecking activity levels on chicken play behavior

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Feather-pecking in laying hens has been suggested to represent an animal model for attention deficit hyperactivity disorder (ADHD) in children. Interestingly, solitarily activities including solitarily focused play are likely to identify children with ADHD. We hypothesized that offspring of laying hens selected for high (H) feather-pecking activity perform higher rates of solitarily focused play behavior than offspring born to birds selected for low (L) feather-pecking activity. In groups of 10, 60 H chicks (1-d-old) and 60 L chicks were kept in identical floor pens littered with a mix of straw and wood shavings under conventional management conditions. Behavioral video observations (20 min per pen) were conducted twice per week in wk 2 to 7 and all occurrences of solitarily play behavior during each time period were recorded. Play behavior was considered as any sequence that contained some or all of the following characteristics: repetition, incomplete, quick, exaggerated sequences; and that lacked final consummatory acts. Data were analyzed using PROC GLIMMIX (SAS 9.3). The number of running events—spontaneous running in circles or in straight line—was not different between the H and L chicks (22.7 ± 2.0 vs 23.4 ± 2.0; ns). The number of hopping events—chicks pushing off with both feet simultaneously and flapping their wings—was higher in H than in L chicks (24 ± 1.9 vs. 17 ± 1.4; P = 0.004). The total number of times an inanimate object (straw) was dropped and picked up multiple times on a given spot, and the number of times an object was dropped and picked up while the bird was running was greater in H than in L chicks (1.5 ± 0.3 vs. 0.7 ± 0.2; P = 0.033). Taken together, our results show that H birds performed higher rates of solitarily play. Further research is warranted to determine whether there is an association between chick’s solitarily play and feather-pecking or aggressive behavior later in life.

Key Words: trimmed comb, trimmed wattle, pullet, behavior, thermography

Effect of partial comb and wattle trim on pullet behavior and thermoregulation

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The comb and wattles of a caged chicken are sometimes trimmed to prevent tearing by equipment. The blood vessels of the comb and wattles facilitate conductive heat exchange during temperature extremes. Our objective was to determine whether trimming the comb and wattles affected behavior, feed consumption, BW, and the surface temperature of the pullet. The comb and wattles of White Leghorns were trimmed at 21 d of age using scissors (n = 6 cages) between 0938 to 1037 h, while the remaining 6 cages of 13 chicks each served as intact controls. Thermal images (collected at 1300 h) of the chick’s comb, wattle, beak, eyes, and shanks were taken, and behavior was measured 3 d before, on the day of, and 1, 2, 4, 6, 8, and 11 d post trim. The proportion of chicks per cage feeding, drinking, standing, sitting, preening, and running was recorded using instantaneous scan sampling observations made every 5 min at 0800 to 0900 h, 1200 to 1300, and 1500 to 1600 h. Feed utilization from 21 to 28 d and 28 to 36 d of age and group BW of chicks at 21, 28, and 36 d of age were measured per cage. Data were analyzed using ANOVA with repeated measures. Proportionally, trimmed chicks were observed feeding less and sitting more on the day of the trim as compared with the controls, but by d 4 post-trim, trimmed chicks were feeding more and sitting less (treatment by age interaction, P = 0.03 and 0.0001, respectively). The proportion of chicks standing only differed on the day of the trim with fewer trimmed pullets standing as compared with controls (66.2 vs. 77.2%, SEM = 1.9, treatment by age interaction, P = 0.0002). The other measured behaviors as well as BW, feed utilization, and chick surface temperature did not differ between treatments. Behavioral indices suggested that pullets subjected to partial trimming of the comb and wattles experienced stress perhaps due to pain on the day of the trim; however, they quickly recovered by returning to normal behavior by 1 d following the trim. The change in behavior on the day of the trim had no long-term impact on feed consumption, growth, or thermoregulation as measured through infrared thermography.

Key Words: laying hen, welfare, feather-pecking, play behavior

Individual tracking of laying hens in aviary cages with different litter substrates

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Alternative aviary-style housing systems for laying hens are designed to provide birds with additional resources including litter, perches, a nestbox and tiered cage structure. These resources aim to cater to behavioral needs of hens such as perching and dustbathing, resulting in improved welfare. But individual hens housed in these systems might not use provided resources to the same degree, possibly leading to between-individual discrepancy in the intended welfare benefits. In large complex systems, hens may also develop preferences for specific areas that they use consistently. We used Bovans white laying hens housed in aviary cages with 3 different litter substrates (straw, wood-shavings, or Astroturf) at Michigan State University’s Laying Hen Facility to test whether each hen spends similar proportions of its day in different areas of the system. Conducting live observations, we tracked 35 color-marked hens in each of 6 cages noting their cage location (8 different locations identified) every 15 min from lights on (0500 h) until lights off (2030 h) across 3 d during the mid-lay period (August 2013). General linear models showed significantly different average proportions of time that all observed hens spent out on the different litter substrates (P < 0.0001) with the least time spent on the Astroturf. ANOVA between individuals, analyzed separately for each of the 6 focal cages (averaged across the 3 sample days), showed significant differences within each cage for where individual hens spent their day (all P < 0.0001). Some hens did have similar patterns of daily movement, but other hens were distinct in the cage locations they preferred and not every hen was seen in every cage location. These results show individual hens housed in aviary cages utilize the provided resources to different degrees, which might depend on the types of resources made available. These results may have implications for laying hen welfare in alternative housing and optimal system design.

Key Words: aviary system, laying hen behavior, resource, welfare, individual differences
207  Effects of space allowance and cage size on production and well-being of laying hens in large furnished cages. T. M. Widowski1,2, L. J. Caston1, M. E. Hunniford1, S. Leeson1, L. Cooley1, M. Guerin1, and S. Torrey1,2, 1University of Guelph, Guelph, ON, Canada, 2Agriculture and Agri-Food Canada, Guelph, ON, Canada.

Proposed changes to housing for laying hens in the US include a transition period of gradually increasing space allowances for hens in furnished cages. However, there is little published data on the effects of housing hens at different densities in these types of housing systems. The objective of this study was to determine the effects of housing laying hens at 2 space allowances in 2 sizes of furnished cages (FC) on measures of production and well-being. A total of 1,218 LSL-Lite hens were housed in cages furnished with a curtained nesting area, perches and scratch mat. At 18 wk birds were housed at either 520 cm² (low) or 748 cm² (high) total floor space resulting in group sizes of 40 vs. 28 birds in the small FC (SFC) and 80 vs 55 in the large FC (LFC). A reference group of 100 hens were kept 5/cage in conventional cages (CC) at 464 cm²/bird. Data were collected from 20 to 72 wk of age. There was no effect of cage size (SFC 94.2%; LFC 93.2%; SEM = 0.15; P = 0.21) or space allowance (High 93.0%; Low 94.4%; SEM = 0.15; P = 0.37) on hen-day egg production, but hens in FC laid more eggs than those in CC (FC 93.7 ± 0.15; CC 92.7 ± 0.57%). Feed intake was higher in SFC than LFC (110.7 vs 105.3 g/d SEM = 1.16; P = 0.005). Egg weight was not affected by FC treatments (P > 0.05) but hens in FC laid heavier eggs than CC. Mortality to 72 wk was not affected by cage size (P = 0.78) or space allowance (P = 0.55) but was higher in FC than CC (4.6 vs 2.0%). BW and BW uniformity were not affected by treatments in FC, but hens in CC were heavier and more uniform than those in FC. Feather condition and cleanliness scores deteriorated in all treatments over time but were increasingly poorer in low vs. high space allowance in FC (age × space: P = 0.02, P = 0.03, respectively). Bone breaking strengths of femur, tibia and humerus were not affected by cage size or space allowance but all bones were stronger in FC than CC. Overall, the cage sizes and space allowances studied in this trial had few effects on production parameters. However, stocking birds at the lower space allowance resulted in poorer external condition in both sizes of FC.

Key Words: laying hen, furnished cage, space allowance, cage size, well-being

208  The utilization of feeder space by hens housed in enriched colony cages. R. A. Blatchford* and J. A. Mench, University of California, Davis, CA.

Housing standards for caged laying hens typically require either that a particular amount of feeder space per hen be provided or that there be sufficient feeder space for all hens to feed simultaneously. Egg producers are increasingly adopting enriched colony systems that contain resources (nests, perches, scratch area) that can affect how feeder space is utilized. However, little is known about feeding behavior in these systems. As part of the Coalition for a Sustainable Egg Supply project, we investigated how hens (Lohmann LSL white) housed in 60-hen enriched colony cages on a commercial farm utilized the feeder space provided (12 cm/hen). Cages (n = 18) were video recorded from 0500 to 2200 h and behavior coded using instantaneous scan samples at 10-min intervals. For analysis, cages were divided into 3 equal sections (each providing 122 cm feeder space), corresponding to the resources available in those sections: nest, perches, and scratch pad. The average number of hens feeding during each hour was analyzed using an ANOVA. The maximum number of hens observed feeding at any one time in a cage was 42. There was a location effect, with fewer hens (P > 0.0001) feeding at the nest section (6.0 ± 0.74 hens) than either the scratch pad (7.0 ± 0.68 hens) or perch (7.0 ± 0.71 hens) sections. There was a time effect (P < 0.0001), with a small peak in feeder use at 0700 h and a large peak between 1800 and 1900 h. There was also an interaction between time and cage section, with the feeders in the nest section (4.9 ± 0.71 hens) used less (P < 0.001) between 0700 and 1100 than those in the scratch pad (8.2 ± 0.25 hens) and perch (7.6 ± 0.46 hens) sections. These results indicate that hens in enriched colony cages do not all feed simultaneously and utilize the feeder space available in different sections of the cage differently. The low occurrence of feeding in the nest section in the morning may be because most hens lay their eggs in the morning and associated the nest section with laying rather than eating. Feeder usage in this section may also have been reduced due to the crowding that occurs in the nest area and blocking of the feeder by hens waiting to enter the nest.

Key Words: laying hen, feeding behavior, enriched colony

209  Welfare Quality Assessment of hen condition across housing systems. R. A. Blatchford* and J. A. Mench, University of California, Davis, CA.

The Welfare Quality Assessment protocol for poultry (WQA) provides animal-based measures allowing for welfare comparisons across farms and housing systems. As part of the Coalition for a Sustainable Egg Supply project, we used the WQA to compare hens housed in an enriched colony cage (EC), aviary (AV), and conventional cage system (CC) on a commercial farm. We scored 100 hens per system on a variety of measures such as physical abnormalities and feather condition. A baseline measure was made at placement at 19 wk of age, since AV hens had been reared in an aviary pullet facility (AVP) while EC and CC were reared in a conventional pullet facility (CCP). Hens were then reassessed at 72 wk of age. WQAs were analyzed using Wilcoxon Two-Sample and Kruskal-Wallis tests. There were only a few differences in the condition of the pullets at placement, with AVP having shorter (P = 0.01) claws than CCP (2.0 ± 0.03 cm vs. 2.1 ± 0.02 cm), dirtier (P = 0.03) feathers (21% vs. 10%), and more (P < 0.0001) keel abnormalities (15% vs. 0%). All pullets were fully feathered. At 72 wk, EC hens had shorter nails (3.2 ± 0.06 cm, P = 0.0002) than AV (3.5 ± 0.06 cm) and CC (3.4 ± 0.06 cm), whereas CC hens had more (P < 0.0001) foot pad lesions (59%) than AV (22%) and EC (14%). AV (45%) and EC (29%) hens had more (P < 0.0001) keel abnormalities than CC hens (13%). AV hens (19%) had dirtier (P < 0.0001) feathers than EC (1%) and CC (0%) hens. While composite feather less scores were low overall (pooled mean: 3.2 ± 0.1 out of a possible score of 14) there were differences in patterns of feather loss, with AV hens having more on the head and vent areas, whereas EC and CC hens had more on the crop, back, and keel areas. Differences were consistent across age, such as AV hens having greater keel abnormalities and dirtier feathers. Other differences developed over time, such as foot pad lesions and feather loss. Feather loss patterns suggest that loss was due to feather pecking for AV hens, whereas for EC and CC it was more likely due to cage wear. These results show the WQA is a useful tool for detecting differences attributable to housing systems.

Key Words: Welfare Quality, enriched colony, aviary, feather loss

North American egg producers are responding to pressures to adopt alternative housing systems for laying hens. It is important to identify risks to well-being of hens in the different systems so farmers can make informed choices. The objective of this study was to compare incidence of keel bone fractures and to benchmark several other measures of well-being in hens housed in conventional cages and single-tier floor housing systems. Commercial brown strain laying hen flocks were selected in Ontario, Canada. There were 29 visits to flocks on 9 farms housing birds in conventional cages (CC) and 26 visits to flocks on 8 farms housing birds in floor barns (FH). The average flock size for caged hens was 16410 hens while the floor housed farms averaged 9607 hens. Each farm was visited at 20, 35, 50 and 65 wk of age. At each visit, 50 birds were sampled from different areas of the barn, weighed, palpatated for presence of healed keel bone fractures, and evaluated for feather score (1 = poor to 4 = good feather cover on head, back, breast, and vent). Farm records were used to record cumulative mortality up to each sampling age. Fracture incidence was higher in FH hens compared to CC (48.3% ± 0.04 vs. 24.8% ± 0.03, P = 0.0001). Hens in CC were heavier (1,888 g ± 26.8) than FH (1,827 g ± 28.8, P < 0.05) but BW uniformity was higher (coefficient of variation: CC, 10.1 ± 0.32%; FH 9.4 ± 0.40%; P < 0.001). Feather score did not vary significantly between the two groups, and there a tendency for cumulative mortality to be higher in FH flocks compared to CC (2.13% ± 0.42 vs 1.29% ± 0.19; P = 0.078). All parameters varied with age (P < 0.0001), which was expected. Housing hens in single-tier floor systems increased the amount of keel fractures that a flock was likely to suffer, and resulted in a decreased, yet more uniform body weight, compared to CC under commercial conditions. Results from alternative housing systems need to be compared to the current industry benchmarks to ensure that progress is being made in improving the well-being of laying hens in the future.

Key Words: welfare, laying hen, housing, keel fracture, well-being

211 Use of an impact tester to assess the likelihood of fractures occurring against key bird and motion related factors. M. J. Toscano*1, F. Booth2, L. J. Wilkins2, S. B. Brown3, G. Richards3, and J. F. Tarlton2, 1Research Center for Proper Housing; Poultry and Rabbits (ZTHZ) Division of Animal Welfare, VPH Institute, University of Bern, Zollikofen, Bern, Switzerland, 2Matric Biology Research Group, University of Bristol, Bristol, United Kingdom, 3Animal Behaviour and Welfare Group, University of Bristol, Bristol, United Kingdom.

Keel bone fractures are a serious welfare problem in laying hens and recent findings suggest that a principal cause are collisions with housing structures. The current work is part of an ongoing effort to develop a methodology that creates collisions representative of that experienced by birds to relate the likelihood of fracture with key bird and motion related factors (e.g., energy during collision, bone health). Fractures were induced in euthanized hens (n = 480 Lohman Brown birds total at 23, 30, 42, 50, and 60 wk of age) using a drop-weight impact tester able to generate a range of impact energies between 0.8 and 16 J. Analysis using logistic regression demonstrated that greater impact energy increased the probability of fracture occurring (P = 0.05) and caused fractures of greater severity (P = 0.03). Interestingly, while increasing age was associated with greater probability of fracture (P = 0.03), this relationship appeared to reverse in older hens aged greater than 44 wk; that is, older birds had reduced probability of fracture, a finding which may relate to bone maturity and bone strength. The particular pattern observed within our ex vivo model appears to be supported by several independent studies examining longitudinal occurrences of fractures. The novelty in our method lies in that fractures can be visualized at the time of collision and can thus eliminate many confounding factors; for example, changes in behavior. Our study offers a unique means to assess fractures and model how various factors relate to the probability of a fracture occurring. Greater understanding of these relationships will provide means to reduce levels of fracture and severity in commercial systems.

Key Words: keel, fracture, welfare, hen, collision

212 Effect of stocking density and litter material on bone and tendon strength, and productive performance in broilers. A. J. Vargas-Galicia1, E. Sosa-Montes2, C. A. Ruiz-Feria2, J. Bautista-Ortega3, A. Pro-Martinez1, L. T. Rodriguez-Ortega4, C. M. Becerril-Perez4, P. Pérez-Hernández5, and A. S. Hernández-Casares4, 1Colegio de Postgraduados, Campus Montecillo, Texcoco, México, 2Colegio de Postgraduados, Campus Campeche, Champoton, México, 3Colegio de Postgraduados, Campus Córdoba, Veracruz, México, 4Universidad Autónoma Chapingo, Texcoco, México, 5Texas A&M University, College Station, TX.

High stocking density decreases growth performance and deteriorates welfare in broilers. The objective of this study was to evaluate the effect of stocking density and litter material on tibia (TiBS) and tendon breaking strength (TeBS), ash content, Ca and P of bone, and body weight (BW). Ross 308 male chicks (n = 744) were raised on volcanic rock (tezontle, TEZ) or wood shavings (WS) litter, with a stocking density of 13 (LDe) or 18 birds/m² (HDe) (2 × 2 factorial; 4 pen replicates/treatment). Right tibias and calcaneus tendons were collected at d 45 (6 birds/treatment) and subjected to breaking strength tests (Newtons); whereas the left tibias were collected for determination of ash, Ca, and P. The final BW (42 d of age) was higher (P ≤ 0.05) in birds housed at LDe (2.56 ± 0.01 kg) than in those housed at HDe (2.35 ± 0.01 kg). An interaction was found for TiBS (P ≤ 0.05); birds on the WS-HDe group showed the highest TiBS (278.5 ± 10.3 N), with no difference among the other treatments (267.4, 244.6, and 244.6 ± 10.3 N, for TEZ-LDe, TEZ-HDe, and WS-LDe, respectively). On the other hand, chickens housed on WS litter showed higher (P ≤ 0.05) TeBS than birds raised on TEZ litter (182.1 vs. 132.1 ± 8.8 N). These results suggest that the stress imposed by the litter material can adversely affect tendon and bone integrity, and this can be due to leg instability of birds raised on TEZ. No difference among treatments was observed for ash content, Ca, or P. Although birds raised at HDe had lower BW, when considering the amount (kg) of meat produced per m², the results were still favorable for the HDe treatment.

Key Words: tezontle, tibia, tendon, stocking density, productive performance


Blackhead disease is caused by the protozoan parasite Histomonas meleagridis and results in increased mortality of gallinaceous birds, particularly turkeys. Presently, nitisone is the only preventative treatment that is approved for use in poultry in the United States. As an arsenical, nitisone has been banned in the European Union and it is likely to be removed from US markets in the near future. The lack of alternative drugs for H. meleagridis infections has led to an increased search for additional methods to prevent and control the disease. Studies using the related protozoa Trichomonas vaginalis and Trichomonas fetus show that high concentrations of zinc inhibit their growth. Based
on this data and the fact that nitarsone contains the metalloid arsenic, we hypothesized that other heavy metals such as zinc (as zinc sulfate, ZnSO₄) and copper (as copper sulfate, CuSO₄) could also inhibit the growth of *H. meleagridis*. We used a culture based screening method to measure *H. meleagridis* growth in the presence of ZnSO₄ and CuSO₄ at 4 concentrations with 5 replicates: 50, 100, 500, and 1,000 ppm. Growth rates were measured at 8-h intervals for 32 h by counting live cells using a Neubauer hemocytometer. Cultures treated with water (control) and 50 ppm of CuSO₄ did not differ significantly (*P* > 0.05) at all times measured. CuSO₄ cultures at 100 ppm and higher showed no live cells by 16 h. Additionally, there were significantly fewer cells at 8 h compared with the control. Cultures treated with ZnSO₄ at 50 ppm and 100 ppm did not differ significantly from the control while cultures with ZnSO₄ at 500 and 1,000 ppm declined to zero by the 32-h time point. Growth was significantly reduced in the cultures treated with ZnSO₄ at 500 and 1000 ppm versus the control at each time point. These in vitro tests demonstrate that ZnSO₄ and CuSO₄ are toxic to *H. meleagridis* at dietary levels that are tolerated by turkeys and chickens. This suggests that the inclusion of zinc and copper in the diet might provide new therapeutic alternatives to controlling this disease.

**Key Words:** blackhead disease, zinc, copper, *Histomonas meleagridis*

### 214 Effect of trace minerals on the development of bacterial chondronecrosis with osteomyelitis in poultry

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Bacterial chondronecrosis with osteomyelitis (BCO) is one of the most common forms of lameness in poultry. It is associated with opportunistic bacterial infections in the proximal long bones and gut barrier failure. Chelated trace minerals have been shown to improve bone strength and gut health, therefore we hypothesize that Mintrex, the chelated trace minerals, can improve bone structural integrity and gut barrier function thereby decreasing bacteria leakage from the gut into the bone and reducing BCO lesions. A wire flooring model was used to test the efficacy of Mintrex in reducing BCO lesions in broilers. Ross 308 male broiler chicks were assigned to 3 treatments with 2 pens per treatment: (1) ITM (Zn:Cu:Mn = 100:125:90), (2) low Mintrex (Zn:Cu:Mn = 32:8:32); (3) moderate Mintrex (Zn:Cu:Mn = 64:16:64). Compared with ITM, low and moderate levels of Mintrex reduced the incidence of tibial head necrosis in day14 non-lame birds (*P* < 0.05); moderate levels of Mintrex reduced the incidence of femoral lesions in all lame birds (*P* < 0.05) and day55 non-lame birds (*P* < 0.05). The impact of Mintrex on BCO lesions in broilers was also tested in a commercial farm. In this trial, Hubbard x Cobb 500 chicks were assigned to 2 treatments with 4 houses per treatment: (1) ITM (Zn:Cu:Mn = 100:125:100); (2) Mintrex (Zn:Cu:Mn = 50:25:50). Lame birds had more severe femoral (*P* = 0.039) and tibial head lesions (*P* = 0.015) than nonlame birds. Mintrex increased tibial diameter (*P* = 0.0023), reduced tibial lesion scores (*P* = 0.087) and the incidence of severe femoral (*P* = 0.11) and tibial head necrosis (*P* = 0.12) compared with ITM. Taken together, Mintrex improved femoral and/or tibial head lesions in broilers reared on wire flooring and on litter, which suggests that Mintrex may be effective in reducing BCO in poultry.

**Key Words:** bacterial chondronecrosis with osteomyelitis, lameness, femoral head necrosis, tibial head necrosis, chelated trace minerals

### 215 Development of techniques to assess moisture held in broiler feathers

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Transportation of wet birds can have detrimental effects on bird welfare and poultry industry economics. Transportation guidelines advise against the transportation of wet birds. However, there is not a method to quantify the level of wetness. Therefore, commercially-available moisture-sensing devices were tested to determine if they could be used to measure moisture contained in broiler feathers. Six moisture-sensing devices were tested on artificial feather beds (15 cm by 15 cm), with varying feather densities (14, 11, 9 or 4 feathers per 25 cm²). The day before testing, distilled water was misted onto dry feather beds (0, 25, 50, 75, 100, 150, 200% of the total feather weight) then stored in sealed plastic bags. Measurements were taken at 5 different locations per feather bed and 4 measurements per location were taken, each at a different orientation in reference to the alignment with the feathers, allowing 20 replicates per feather density and moisture level combination. Following testing with the moisture sensing devices, the true moisture concentration of the feather beds was determined using a gravimetric technique. A separate regression analysis was conducted for each sensor and each feather density was analyzed separately. A linear relationship was identified between true moisture content and device readings for all the devices (*P* < 0.05). Of the 6 devices tested, a Delmhorst hay sensor and a General Tools and Instruments construction moisture sensor were identified as devices warranting further testing, based mainly on the accuracy and consistency of the readings. These 2 sensors showed the least variability between the measurements (standard error = 1.47 and 1.35, for the Delmhorst and General sensors respectively) compared with other devices (standard errors ranged from 2.93 to 3.93). The selected devices also were less affected by feather density, as demonstrated by the more consistent slopes between the moisture contents (Delmhorst = 0.26 to 0.46 and General = 0.30 to 1.10). Based on the results, General and Delmhorst sensors were selected to undergo further testing using live birds.

**Key Words:** moisture-sensing device, wetness, broiler, feather, transportation