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0.05-2 G) to continuously monitor activity from day 22 to 46; accelerometers were previously validated through video analysis. The number of 15-second epochs with no activity were summed per day per bird and analysed using a repeated measures generalised linear mixed model. For analyses, SLOW strains were further categorised as fast SLOW (F-SLOW, ADG_{0-61} = 54-56 g/day), moderate SLOW (M-SLOW, ADG_{0-61}= 50-51 g/day) and slow SLOW (S-SLOW, ADG_{0-61} = 44-48 g/day). Overall, CONV birds were inactive for 18.4 ± 0.6 h per day, whereas SLOW birds were inactive for 17.4 ± 0.6 h per day ($p = 0.07$). Inactivity increased with age ($p < 0.01$), and females were more inactive than males ($p < 0.01$). At the same age, CONV chickens were more inactive than S-SLOW chickens until day 35 ($p < 0.01$). At the same target body weight (~2.1 kg; d34 for CONV, d48 for SLOW), CONV birds were less inactive than S-SLOW ($p < 0.01$), M-SLOW ($p < 0.01$) and F-SLOW birds ($p < 0.01$), but the inactivity levels of the S-SLOW, M-SLOW and F-SLOW birds were similar (all $p > 0.05$). At a higher body weight (~3.5 kg; d48 for CONV, d62 for SLOW), there were no differences in inactivity between strain categories. Results suggest that strain differences in inactivity may initially be due to differences in the speed of growth, with later increases in inactivity due to both age and increasing body weight. Wearable accelerometers permit the continuous monitoring of broilers to identify activity patterns that may be proxies for welfare, such as long durations of inactivity, which may be associated with poor leg health or a reduced physical ability to perform natural behaviours.

Key Words: behaviour, broiler, slow grow, welfare

32 Utilizing 3-dimensional models to assess keel bone damage in laying hens throughout the lay cycle. Brittney Emmert[UG*2], Prafulla Regmi[1], Cara Robison[2], Kaylee Montney[2], Darrin M. Karcher[3], [1]*Department of Poultry Science, North Carolina State University, Raleigh, North Carolina, United States,* [2]*Department of Animal Science, Michigan State University, East Lansing, Michigan, United States,* [3]*Department of Animal Science, Purdue University, West Lafayette, Indiana, United States.*

Currently, 20% of the 340 million laying hens in the US are cage-free, and this is projected to increase as consumer demand for cage-free eggs rises. Cage-free systems have an increased incidence of keel bone damage, which may result in decreased egg production and compromised well-being by causing pain and possibly reducing their ability to effectively navigate their environment. The objective of this study was to determine the effects of dietary supplementation of n-3 fatty acids and vitamin D on keel bone damage in hens housed in a multi-tier aviary system (AV). A total of 2304 brown hens were placed in AV system after rearing at 17 wks with each room containing 4 sections of 576 birds each. At 12 wks, hens were randomly assigned to dietary treatments of FL (flaxseed oil), FS (fish oil), Vit (25-hydroxy Vitamin D3; 2760 IU/kg), and standard (AC) with one treatment/room. For each treatment, 36 focal birds were longitudinally examined for keel bone damage using computed tomography (CT) scans at nine time points starting at 16 wks until 52 wks. Mimics software (Materialise, Plymouth, MI, USA) was used to create 3-D digital twins of the keels from the CT scans. The 3-D digital twins from each time point were visually assessed for damage in MeshLab (Open Source software). For each keel, an overall severity score was recorded as well as the location, direction, type, and severity of each individual deviation or fracture. Severity was ranked on a 0-5 scale with 0 being no damage and 5 being severe. Binary and multinomial scores were analyzed using the mixed model ANOVA with main effects of treatment and age. Regardless of treatment, at 16 wks, 80% of hens had overall keel scores of 0 and 20% had scores of 1. At 52 wks, all hens had some damage, with 30% having a score of 1, 61% scored 2-3, and 9% scored 4-5. Keel deviation prevalence increased with age from 24% at 16 wks to 52% at 18 wks and 97% at 52 wks ($P < 0.01$). Fractures were not observed until 20 wks and number of hens with fractures increased at every time point after 22 wks ($P \leq 0.03$). Among the treatments, AC birds had 20% more fracture prevalence than FS birds (85% vs. 65%; $P = 0.08$), whereas Vit and FL birds were intermediate (74% and 70%, respectively). For deviations, the Vit group had more total deviation incidents compared to FL ($P = 0.05$). Overall, incorporating fish oil in the diet could reduce keel fractures, however, majority of laying hens in an AV system are still vulnerable to some form of keel damage.

Key Words: keel, computed tomography, laying hen, 3-D model, aviary

33 Automatic detection of reproductive behavior in male Japanese quail (*Coturnix japonica*) using accelerometers and neural networks. Catalina Simian[1, 2], Lucas M. Barberis[3], Raul H. Marin*[1, 2], Jackelyn M. Kembro[1, 2], [1]*Universidad Nacional de Córdoba, Facultad de Ciencias Exactas, Físicas y Naturales, Instituto de Ciencia y Tecnología de los Alimentos (ICTA) and Cátedra de Química Biológica, Cordoba, Argentina,* [2]*Consejo Nacional de Investigaciones Científicas y Técnicas (CONICET), Instituto de Investigaciones Biológicas y Tecnológicas (IIByT, CONICET-UNC), Cordoba, Argentina,* [3]*Consejo Nacional de Investigaciones Científicas y Técnicas (CONICET), Instituto de Física Enrique Gaviola (IFEG, CONICET-UNC), Cordoba, Argentina.*

Tri-axial accelerometers placed on an animal measure the 3-dimensional acceleration vector associated with body movements over time. When combined with machine learning and data processing techniques, such as neural networks, this methodology has the potential for classifying the recorded acceleration data into behavioral categories. Herein, we propose a system that implements the use of an accelerometer attached to male Japanese quail as a useful way for automatic detection of male reproductive behavior. Two different methods for attaching the accelerometer to the birds were also tested. Fifteen males and thirty females were divided into one of three experimental groups: 1) control without accelerometer attached, 2) using an accelerometer attached to a backpack (i.e. harness fitted by 2 elastic fabric bands around the wings' base) or 3) using an accelerometer attached to a patch made of fabric glued to the back of the bird. All males were handled similarly and remained individually housed during a one-week period until testing. The test initiated when a male was introduced into the homebox of two female belonging to the same experimental group, during a 1-hour period. One camera above and one on the side of the box were used to record behaviors. From video-recording, a high resolution ethogram was performed defining all observable male behaviors at a 1/15s resolution during the first 10-min of testing (9000 data time points per bird). The number and duration of detected behavioral events were estimated. Accelerometer data was collected during the total 60-min of testing. General linearized models were used to assess differences between groups in the most frequently observed behavioral events, namely immobility, vigilance, shakes, exploration, walking, running, grabs, and mounts. In the vast majority of the variables evaluated no differences were observed between groups (P>0.05), including number and durations of mounts. In a second stage, the high-resolution behavioral time series registered from video-recordings were used first to train and then to validate a neural networks, to automatically detect within the accelerometer data the male reproductive events. Noteworthy, all displays of reproductive behavior during the 1-hour testing period were detected with this method. Thus, the proposed system is a first step towards automating the detection of reproductive behaviors relevant for studies where visual observations of video-recording are either not possible or impracticable. In particular, this methodology could be useful to assess male reproductive patterns over time within different social and environmental contexts.

Key Words: Japanese quail, social behavior, reproduction, accelerometry, remote detection systems

34 A machine vision-based method for monitoring broiler floor distribution in feeding and drinking zones.

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In commercial broiler houses, animal floor uniformity and distribution in drinking, feeding, and resting zones are critical information for evaluating flock production, health, and wellbeing. Proper distribution in the house is an indication of a healthy flock. Daily routine inspection of broiler flock distributions is done manually in commercial grow-out houses, which is labor intensive and time consuming. This task requires an efficient system that can monitor birds' floor distributions automatically. In this study, a machine vision-based method, i.e., back propagation (BP) neural network algorithm, was developed and tested in a research broiler house at the University of Georgia. Six identical pens (1.84 L×1.16 W m) were used to raise Cobb-500 broiler chickens (21 birds per pen) from d1 to d49 to test the new method. Each pen was monitored with a HD camera (PRO-1080MSFB, Swann Communications Santa Fe Springs, CA) on ceiling (2.5 m above floor) to capture video (15 frame/s with the resolution of 1440 ×1080 pixels) of group birds. For machine-vision based method to recognize birds' distribution on images, the pen floor was virtually defined/divided as drinking, feeding, and activity/rest zones. Broiler management (e.g., feeding, drinking, lighting, and house air temperature) followed the industry standards. As broiler chickens grew, images collected from each individual day are analyzed separately to avoid the bias caused by change of body weight/size over days. From a whole flock cycle test, about 7000 high quality images from d18-d35 were selected to build the BP network model for floor distribution analysis. Images from each day were randomly selected for model validation. A one-way ANOVA was used to test if there were significant differences in the detection speed of broiler chickens on the same image between the method developed in the current study, K-means, and FCM. The effect was considered to be significant when *P*-value was less than 0.05. Results showed that the identification accuracy of birds' distribution in the drinking and feeding zones are 0.954 and 0.942, respectively, which provides a tool to quantify the time budget of animal feeding and drinking behaviors for improving equipment design. The current method required less time in clustering than K-means and FCM methods ($p<0.001$).The correlation coefficient R, mean square error (MSE), and mean absolute error (MAE) of the BP model was 0.996, 0.038, and 0.178, respectively, in analyzing broiler distribution on pen floor. The missed detection was mainly caused by blocks or interferences of facilities (e.g., feeder handing chains and drinker pipes) on chickens' floor images. Studies are ongoing to address those interreference issues.

Key Words: Broiler chicken, health and welfare, animal behaviors, precision farming