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Modification of aviary design reduces incidence of falls, collisions and keel bone damage in laying hens

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ABSTRACT

Non-cage housing systems for laying hens such as aviaries provide greater freedom to perform species-specific behavior and thus are thought to improve welfare of the birds; however, aviaries are associated with a high prevalence of keel bone damage (fractures and deviations), which is a major welfare problem in commercial laying hens. Potential causes of keel bone damage are falls and collisions with internal housing structures that occur as birds move between tiers or perches in the aviary. The aim of this study was to investigate the scope for reducing keel bone damage by reducing falls and collisions through modifications of aviary design. Birds were kept in 20 pens in a laying hen house (225 hens per pen) that were assigned to four different treatments ($n = 5$ pens per treatment group) including (1) control pens and pens modified by the addition of (2) perches, (3) platforms and (4) ramps. Video recordings at 19, 22, 29, 36 and 43 weeks of age were used to analyze controlled movements and falls (including details on occurrence of collision, cause of fall, height of fall and behavior after fall) during the transitional dusk and subsequent dark phase. Palpation assessments (focusing on fractures and deviations) using 20 focal hens per pen were conducted at 18, 20, 23, 30, 37, 44, 52 and 60 weeks of age. In comparison to the control group, we found 44% more controlled movements in the ramp ($P = 0.003$) and 47% more controlled movements in the platform treatments ($P = 0.014$) as well as 45% fewer falls ($P = 0.006$) and 59% fewer collisions ($P < 0.001$) in the ramp treatment. There were no significant differences between the control and perch treatments. Also, at 60 weeks of age, 23% fewer fractured keel bones were found in the ramp compared with the control treatment ($P = 0.0053$). After slaughter at 66 weeks of age, no difference in keel bone damage was found between treatment groups and the prevalence of fractures increased to an average of 86%. As a potential mechanism to explain the differences in locomotion, we suggest that ramps facilitated movement in the vertical plane by providing a continuous path between the tiers and thus supported more natural behavior (i.e. walking and running) of the birds. As a consequence of reducing events that potentially damage keel bones, the installation of ramps may have reduced the prevalence of keel fractures for a major portion of the flock

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cycle. We conclude that aviary design and installation of specific internal housing structures (i.e. ramps and platforms) have considerable potential to reduce keel bone damage of laying hens in aviary systems.

1. Introduction

Following the ban of battery cages in Europe from January 2012 (CEC Council Directive 1999/74/EC), non-cage housing systems, including aviary systems, are becoming more common in the egg-producing industry. Non-cage housing systems for laying hens (e.g. aviary systems) are thought to improve the welfare of the hens by providing greater freedom to perform species-specific behavior and satisfying specific behavioral needs such as ground scratching, dust-bathing and comfort behavior (Appleby and Hughes, 1991; Lay et al., 2011). Further benefits to animal welfare include access to nests, elevated perches and litter. Although variable in form, aviaries consist of stacked tiers, with each tier serving different purposes like feeding, drinking and provision of nests and perches (Aerni et al., 2005). Compared to caged systems, space availability per hen is increased and includes the third dimension to allow for flying, which is assumed to improve bone health (Leyendecker et al., 2005). Despite these benefits, aviaries are often associated with their own problems such as a relatively high incidence of broken keel bones (Käppeli et al., 2011; Rodenburg et al., 2008). Prevalence of keel bone damage (fractures and deviations) is greater in aviaries compared with furnished cage systems: reported prevalence in aviaries varies between 56 and 96% (Käppeli et al., 2011; Rodenburg et al., 2008), whereas the prevalence in furnished cages varies between 23 and 30% (Habig and Distl, 2013; Sandilands et al., 2009). Given that keel bone fractures are believed to be painful (Nasr et al., 2012a) and associated with reduced egg production (Nasr et al., 2012b) and increased mortality (McCoy et al., 1996), keel bone damage is one of the major welfare problems associated with laying hens in aviaries. Falls and high energy collisions with internal structures that occur as birds move between tiers or perches are likely to be one of the major sources for the high prevalence of keel bone damage in aviaries (Gregory and Wilkins, 1996; Moinard et al., 2004). Indeed, frequent falls and collisions were observed in a commercial aviary system, especially during the beginning of the dark period (Stratmann et al., accepted). Various studies have shown that perch arrangements affect the hens' ability to move between perches (Moinard et al., 2005; Scott and Parker, 1994), indicating that movements across larger distances and steeper perch angles are more difficult for the birds to perform and thus likely result in accidents (i.e. fall or collision). Therefore, better knowledge as to why, when and where falls and collisions occur is important to reduce keel bone damage. The aim of the present study was to assess the scope for reducing keel bone damage by reducing falls and collisions through modifications of aviary design, using the following three variations: (1) additional perches providing greater opportunities for birds to grip and hold on, preventing birds from falling, (2) platforms in addition to perches to enlarge landing areas and facilitate safe landings and (3) ramps to reduce the height of fall and to facilitate maneuvering between different tiers. We predicted fewer falls and collisions and, as a consequence, reduced keel bone damage (i.e. keel bone fractures and deviations) in all three treatment groups with modified aviary design (i.e. additional perches, platforms or ramps) compared with the conventional control design.

2. Methods

2.1. Ethical statement

All procedures were approved by the Veterinary Office of the Canton of Berne, Switzerland (Cantonal license number BE 99/11) and all corresponding ethical guidelines were followed. Before the study began, criteria were established for the physical health of birds as to when experimental animals would be euthanized when welfare was seen to be compromised. Criteria included inability to walk/perform natural motion (i.e. flying, jumping and wing flapping) and/or gross or open lesions. No focal animals met these criteria, but several non-study animals of the flock had to be euthanized for these reasons by animal care staff, which is standard practice in commercial settings. Culling of individual animals was performed by a concussive blow to the animal's head followed by cervical dislocation, a procedure accepted as a legal form of killing in laying hens in Switzerland (animal protection guideline 800.116-3.01, BLV).

2.2. Animals and housing

In total, 4500 Lohmann Selected Leghorn (LSL) chicks were raised from hatch until 18 weeks of age in eight pens of a rearing barn equipped with two different aviary systems (four pens with Inauen Natura, Inauen AG, Appenzell, Switzerland, and four pens with Landmeco Harmony, Globogal AG, Lenzburg, Switzerland). The rearing aviaries were similar in that they consisted of four tiers (both 220 cm high). For each, a manure belt, nipple drinkers and feeding chains were on the first and third tier and perches on the fourth tier. The principal difference in rearing aviaries was the position of the tiers where the Inauen Natura had a continuous tier at each level, whereas the second tier in the Globogal Harmony was split lengthwise so that one side was 10 cm above the other. The floors of all pens were covered with wood shavings and half of the pens had access to a porch (all Inauen Natura). At 18 weeks of age, the hens were transferred to a commercial laying hen house and distributed across 20 pens (225 hens per pen, each measuring 450 × 700 × 230 cm) after being banded with a pen-specific colored leg band. Hens of the two rearing systems were alternately allocated to the pens of the