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Keel bone damage in laying hens – Effect of soft perches, aviary design and genetic selection of bone strength

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Summary

Keel bone damage – specifically bone fractures and bone deviations – is a major welfare problem in commercial laying hens and possibly the greatest welfare issue egg production is currently facing. Different studies report frequencies of keel bone damage varying between 56% and 97% of affected birds per flock indicating that millions of birds are affected. Causes for keel bone damage are assumed to originate from two factors: genetic selection for increased egg production and inappropriate housing design. Genetic selection for increased egg laying rate is believed to result in loss of structural bone mass, which leads to weakened bones prone to fracture. In terms of housing design, the shift away from battery cages (Switzerland in 1992, EU in 2012) to alternative housing systems such as aviaries allows for greater freedom to move and fly, which likely leads to a higher incidence of keel bone fractures due to high energy collisions in these systems.

However, aviary systems improve the welfare of laying hens by providing access to nests and elevated perches as well as greater freedom to perform species-specific behaviours such as dust bathing and ground scratching. The two categories of keel bone damage – fractures and deviations – likely have different prevalence and origins: fractures are assumed to be caused by short-term, high energetic impacts, which occur during collisions with perches or other housing structures. In contrast, keel bone deviations are assumed to result from extended perching behaviour and related to long-term pressure on the keel bone.

The general aims of this thesis were to identify causes of keel bone damage and generate expertise for novel approaches to reduce the high prevalence of keel bone fractures and deviations in commercial laying hens in aviary systems. A specific focus was set on the applicability of the results to make them available and useful for commercial production.

The focus was set on the main causes thought to be related to keel bone damage including perch material, aviary design and genetic selection and questions were addressed correspondingly:

1. Do soft perches have the potential to reduce keel bone fractures and deviations under commercial conditions? (Chapter I)
2. How does the design of an aviary system affect the incidence of falls and collisions, and can the incidence of keel bone fractures and deviations be reduced by targeted modifications of a standard aviary design? (Chapter II)
3. Does genetic selection for bone strength influence the incidence of keel bone damage and external egg quality under commercial conditions? (Chapter III)

In chapter I, we investigated the effectiveness of soft perches to reduce keel bone fractures and deviations in laying hens. Over the course of one laying cycle (18 – 64 weeks of age) we assessed the keel bone status of white and brown laying hens that were either kept in pens equipped with metal perches or perches that were covered with a soft polyurethane material in a 2 x 2 factorial design. Results suggest that the soft perch material reduced the incidence of both keel bone fractures (soft 15.4% vs. met-

al 21.5%) and deviations (soft 29.5% vs. metal 38.7%) over the course of the experiment. However, near the end of lay at 64 weeks of age no difference between treatment groups was found. As a mechanism for the difference we suggest that the soft perch material provided a buffering effect during high energy collisions and thus reduced the incidence of keel bone fractures by reducing the force occurring at the keel bone. In addition, reducing the local pressure load and a more evenly distributed pressure during long term perching is suggested to have led to a reduction of keel bone deviations.

In chapter II, the design of a commercial aviary system was modified using the following three variations: i) additional perches installed at the edges of the aviary tiers providing greater opportunities for birds to grip and hold on to, ii) platforms instead of perches to enlarge landing areas and facilitate safe landings, and iii) ramps to reduce height of fall and to facilitate maneuvering between different tiers. We recorded the number of planned movements, falls and collisions per treatment group and analyzed falls in detail including cause of falls, height of falls and behaviour after falls. The keel bone status of focal hens was assessed during one laying cycle (18 – 60 weeks of age). Compared with the control design, we found 44% more planned movements as well as 45% fewer falls, 59% fewer collisions and 23% fewer keel bone fractures in the ramp group suggesting that ramps facilitated vertical movements between the tiers by supporting more natural behaviour of the birds (i.e. walking instead of flying). As a consequence of reducing events that potentially damage keel bones, the installation of ramps may has reduced the prevalence of keel bone fractures as well. We hereby provide an easy applicable and cost effective mechanism on how to reduce keel bone damage in commercial laying hens in aviary systems.

In chapter III, we investigated the prevalence of keel bone damage and external egg parameters of two pure lines selected for divergent bone strength - high versus low bone strength - in an aviary system under commercial conditions. The commercial LSL hybrid was used as a reference. We assessed the keel bone status and body mass of focal birds of each line over the course of one laying cycle (18 – 63 weeks of age) and compared external egg parameters such as egg breaking strength, shell thickness, egg mass and shell mass between lines at 38 and 57 weeks of age. Bone mineral density was assessed per line using dissected keel bones after slaughter. Compared with the LSL and the low bone strength line, the high bone strength line had fewer keel bone fractures (high line: 13%, low line: 27%, LSL: 37%), but also poorer external egg quality in terms of reduced egg breaking strength and thinner egg shells compared with the low line. Also, mortality was higher and body mass was lower in the high and low line compared with the LSL hybrid. This study suggests that selection of specific bone traits associated with bone strength may be promising traits to reduce keel bone damage and should be implemented in genetic selection procedures for commercial laying hens.