Comparing bone stability of laying hens differing in phylogeny and performance level in two husbandry systems

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Introduction Poor bone quality and fractures due to by osteoporosis cause major welfare and economic problems in laying hens (WEBSTER, 2004). In this context, reduced bone stability is often attributed to long-term selection for increased egg production (SILVERSIDES et al., 2012; JOHNSSON et al., 2015). The aim of this study was to characterize the hens' bone stability in relation to their laying performance and phylogenetic origin when kept in different housing systems.

Materials and Methods The animal model comprised four purebred layer lines (*Gallus gallus domesticus*), differing in phylogeny (brown vs. white-egg layers) and performance level (low vs. high performing strains): BLA (brown/high), WLA (white/high), L68 (brown/low), and R11 (white/low). In this context, laying rate of low performing lines were one third lower than of high performing strains. The study was designed in two consecutive generations with 1.315 hens in total, kept in floor pens (n=771) and individual cages (n=544), respectively. In cages, individual laying rate was recorded from the beginning of the 18th week of age. At the end of the 70th week of age, all hens were sacrificed and dissected. Both, left humerus and tibiotarsus were removed from muscles and tendons and used to assess bone breaking strength via three-point bending Instron Materials Testing System. Analogous to FLEMING et al. (2006), breaking strength was defined as maximum load achieved during the test. Hens were excluded from the analysis if the total number of eggs was decreased by three standard deviations within line and/or if they had zero egg production over the last three weeks, respectively. All procedures conducted in this study were in accordance with the guidelines issued by the German animal protection law and were reviewed and approved by the relevant authorities.

Results Analysis of variance revealed a highly significant ($p<0.0001$) influence of both the genetic line and the housing system on humerus' and tibiotarsus' breaking strength, while the interaction was only significant ($p<0.0001$) for humerus (tibiotarsus: $p=0.9954$). No considerable differences between generations were observed, although the effect was significant. Generally, single cages led to lower bone stability but as shown in Figure 1 the two types of bones studied reacted differently. Humerus breaking strength of cage-housed animals was reduced by 46%, while for tibiotarsus, the average difference was only 26%. There was no consistent pattern of breaking strengths in relation to phylogeny or performance type. A correlation analysis within each line for hens housed in cages revealed rather low and non-significant ($p>0.05$) associations between egg production and bone stability.

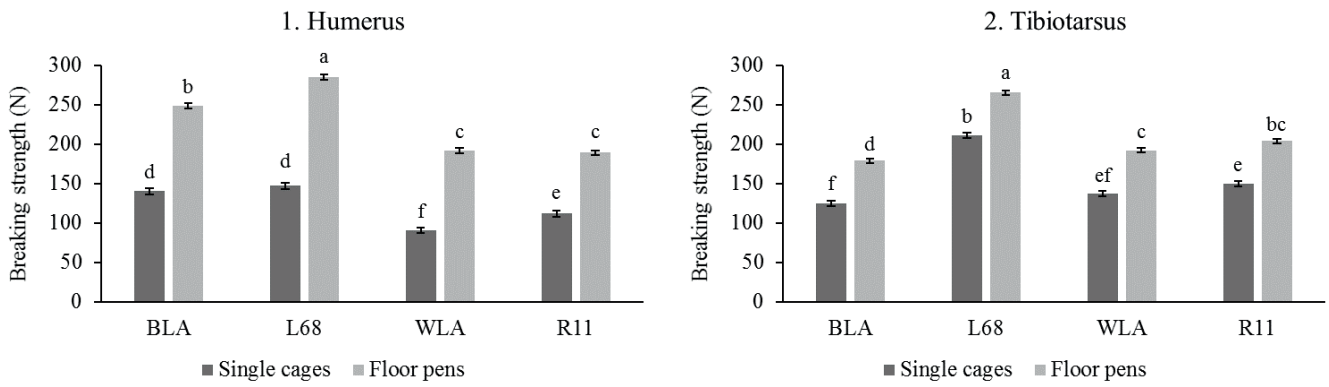

Figure 1 Bone breaking strength of humerus (1.) and tibiotarsus (2.) in four different layer lines kept in single cages (n=136) or floor pens (n=192) (LSM ± SEM, Tukey's HSD test).

Conclusions Our study supports earlier findings that both, genetic line and husbandry system have a major effect on bone stability (RAYMOND et al., 2018), but does not provide evidence for an effect of laying performance within the lines studied.

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