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First approach validating a scoring system for foot-pad dermatitis in broiler chickens developed for application in practice

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ABSTRACT

Measuring the severity of foot-pad dermatitis is an accepted tool monitoring the quality of animal husbandry and welfare. Up to now, a variety of scoring schemes have been used, most of them based on visual evaluation. However, a standardisation and validation of scoring systems is beneficial, not only to compare different studies, but to provide objective indicators in poultry welfare. In this study, we validated one visual scoring system, widely used in Northern Germany, by using additional information of histological measurements. Therefore, feet of broiler chickens (ROSS 308) from one flock were visually scored at the slaughter plant (4-point score). Ten feet per score level (n = 40) were sampled and analysed macroscopically and microscopically. Data were analysed using cluster analysis, providing a classification based on these histopathological findings. Validity of the visual scoring system was analysed by (1) testing the interobserver reliability between different observers and (2) by comparing both, visual and cluster classification types using the McNemar's test. In a last step Kendall tau correlations were calculated in order to find suitable parameters to judge the severity in a visual score more reliably. Results could show that most agreement was found for the score levels 1 and 2, whereas results for score levels 3 and 4 were more divergent. These results were found in both, interobserver reliability and comparison of classification types (visual vs. cluster). Results revealed interaction effects of classification type and scoring level for the width of ulcers ($p = 0.0044$) and the size of the lesion ($p = 0.0081$). In the cluster classification, higher values in both, width of ulcer and size of lesion could be found in score level 3. Furthermore, a positive correlation of the size of lesion with the depth of the ulcer was found (0.73). In conclusion, we found that histological findings coincided well with the less severe visual scores (1; 2), whereas the differentiation between the severe scores (3; 4) seemed to be less valid. For practical purposes we therefore recommend keeping visual scoring systems simple. Furthermore, as the correlation coefficient between both was quite high, the size of the lesion might serve as an indirect indicator of the depth.

1. Introduction

Foot-pad dermatitis is an important indicator of animal welfare in the poultry industry. It is a contact dermatitis of the plantar surface of the feet of broiler chickens. Closely related alterations can also be found on the hock (hock burns) and the breast (breast blisters) (Haslam et al., 2007). The pathology is characterised by inflammatory lesions on the skin, diagnosed by the observation of brown-black spots on the underside of the feet (Martrenchar et al., 2002). These lesions develop from a discoloration of the skin to a hyperkeratosis of the epidermis and finally to serve damage with erosions and ulcerations of the skin and their structures underneath (Greene et al., 1985).

Foot-pad dermatitis (FPD) is very likely to induce pain (Algers and Berg 2001) even if the impact of pain has not yet been analysed scientifically. Still, there are hints that birds suffering from FPD show impairments of the gait patterns. Harms and Simpson (1975) found birds to show instable walking, a result which was confirmed by Hester (1994), who found FPD to influence gait stability. Gait is one important indicator for pain used in different farm animals such as in cows (Weary et al., 2006), sheep (Gigliuto et al., 2014) or pigs (Grégoire et al., 2013). Therefore, there is good case to accept FPD as a relevant indicator of animal welfare. Additionally, birds suffering from FPD show reduced weight gain (Martland, 1985) which is discussed as pain-induced decreases in feed intake (Shepherd and Fairchild, 2010). Therefore, freedom of FPD is not only relevant to ensure animal welfare but also for economic aspects. For animal health, FPD prevents a further

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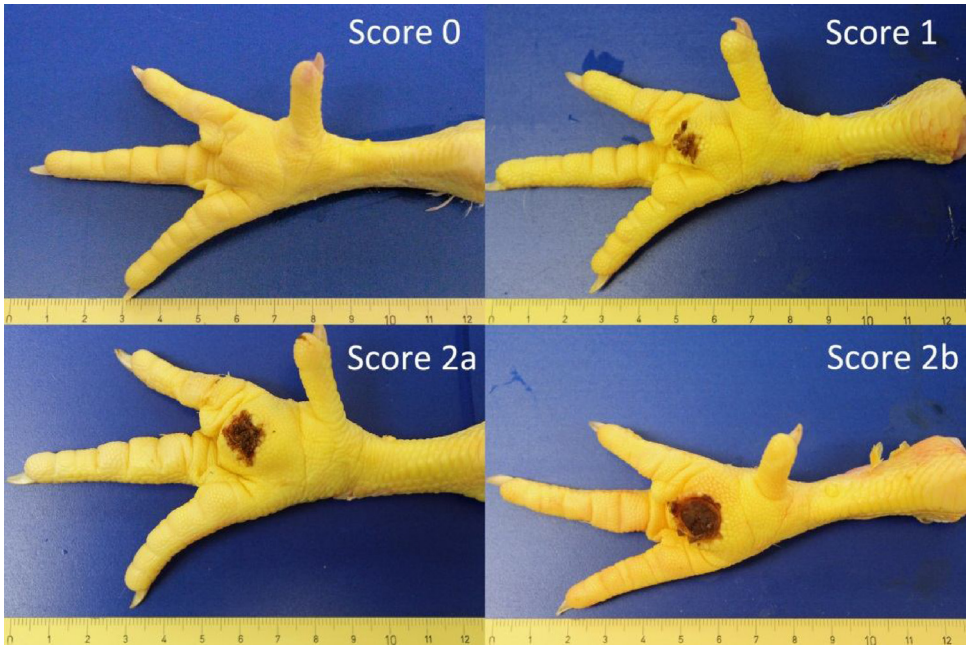

Fig. 1. Visual classification type according to the Regulations implemented by the Lower Saxonian Ministry of Nutrition, Agriculture and Consumer Protection in § 20 (4; 5) from the German Order on the Protection of animals and the Keeping of Production Animals (2006) (Photographic: S. Heitmann).

problem as it might enable infections with pathogens such as *Staphylococcus aureus* (Hester, 1994).

Not only is FPD directly linked to the health state of the animals but it can indirectly provide evidence of their management as it is associated with the litter quality. In commercial broiler production, fresh bedding material is provided at the start of the rearing period. It is unusual to remove the litter thereafter. Therefore, during each rearing period increasing amounts of moisture and nutrients are cycled through the litter and provide a basis for the development of FPD. Main factors associated with FPD are wet litter and high concentrations of ammonia, both influenced by several management factors, which include among others drinker design, nutrition, ventilation, litter quality and material, diet as well as stocking density (Martland, 1985, Spindler and Hartung, 2007, Tucker and Walker, 1992, Mayne et al., 2007b).

Therefore, measurement of the severity of FPD is used in both, rearing period and slaughter, to monitor management and animal welfare. However, no standardised scoring scheme exists, but a broad range of different systems can be found. Methods range from three-point scales (Bilgili et al., 2006, Ekstrand et al., 1998) over four-point scales (Martland, 1985, Martrenchar et al., 2002) to scales which are even more detailed, differentiating up to six different stages of FPD (Ask, 2010). Definitions of the damage vary as well; for instance, scales can describe the percentage of the lesion covering the foot-pad (Martland, 1985, Martrenchar et al., 2002), or describe the depth (Ekstrand et al., 1997) or the size of the lesion (Dawkins et al., 2004), or a combination of size and severity (Allain et al., 2009). Additionally, different modifications of above mentioned systems are used, depending on the respective focus of the various studies (Saraiva et al., 2016). The majority of these scoring methods rely on the macroscopical appearance of lesions, although findings in turkeys could show that such external scores might not be analogous to the histopathological incidence of disease (Mayne et al., 2007a). However, there are also studies in broilers describing the FPD histopathologically (Greene et al., 1985, Martland, 1985). Whereas those studies do not consider the analogy of macroscopical and histological appearance, Michel et al. (2012) draw a linkage between both, macroscopical scores and their histopathological background. They propose a five-point scale, based on three degrees of severity in histological findings and the size of the lesion on a macroscopical basis (Michel et al., 2012). Based on these findings, the presented study goes one step further. As opposed to using a rather subjective classification of the histopathological results, we here present a classification of foot-pad lesions resting on an empirical dataset, based on different parameters such as the thickness of the different layers of the skin as well as the severity of ulceration or hyperkeratosis. Using these histological findings, the aim of this study was to find suitable parameters for judging the severity in a visual score more reliably. Furthermore, our purpose was to compare this empirical classification to the standard classification for FPD used in slaughterhouses in Germany, in order to improve the reliability and validity of monitoring FPD in processing plants as one important welfare indicator for poultry.

2. Material and methods

2.1. Selection of samples

Chicken feet (n = 166) were randomly collected at a slaughter plant in Lower Saxony, Germany (Wiesenhof, PHW-Group Lohmann & Co. AG, Germany; up to 432,000 slaughtered animals per day). Only the right foot was taken (166 feet in total). Samples originated from broiler chickens (ROSS 308) all raised in one flock in Lower Saxony. Animals were kept with a stocking density about 35 kg/ m^2 and the flock consisting broiler chickens of mixed sexes. Wood shavings were used for litter with about 600 g per m^2. The broiler chickens were fed a commercial standard fattening diet (chick starter, breeding feed, finisher; MEGA Tierernährung, GmbH & Co., Germany). They were vaccinated against Newcastle disease (day 6), against Gumboro (infectious bursal disease) (day 17) and against infectious bronchitis (day 19). The stable was equipped with six straw bales. After 35 days of life, the broiler chickens were slaughtered.

2.2. Visual scoring

A total of 166 feet were taken randomly from the slaughter line, collected in a box and scored subsequently. Observations were conducted by an experienced observer (observer 1), using a visual scoring system for broiler chickens, approved by regulations implemented by the Lower Saxonian Ministry of Nutrition, Agriculture and Consumer