

Effect of Litter Moisture on the Development of Footpad Dermatitis in Broiler Chickens

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ABSTRACT. Broiler chicks were reared on either wet litter or dry litter to compare the development of footpad dermatitis (FPD). Broilers reared on wet litter first developed FPD at 14 days of age. Their FPD scores increased sharply after 21 days of age, reaching 2.92 at 42 days. In broilers reared on dry litter, FPD was first observed at 28 days of age, and the FPD score was only 0.70 at 42 days. When 21- or 28-day-old broilers that had been reared on wet litter and had developed FPD were moved to dry litter, the progression of FPD was suppressed or delayed. These results suggest that reducing litter moisture is effective in preventing FPD and suppressing disease progression.

KEY WORDS: broiler, footpad dermatitis, prevention, wet litter.

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Footpad dermatitis (FPD) has been known for several decades in Europe and North America, and its prevalence is especially high among floor-housed broilers and turkeys [1, 4, 6, 16, 19]. More recently, the disease has become a major point of discussion as an important indicator of animal welfare [2, 3, 9, 10, 21].

Due to their culinary importance, chicken paws are exported to China and Southeast Asia. In Japan, chicken paws are called *momiji*, *i.e.*, Japanese maple leaves, for their shape and account for an important segment of the broiler market. Hence, FPD can lead to a significant economic loss for producers, because paws with FPD are not suitable for human consumption and must be condemned. Nonetheless, the etiology and epidemiology of FPD have received little interest, if any, in Japan.

Recently, we conducted a nationwide survey on FPD in broilers and reported its high and wide prevalence in Japan, although the incidence varies among farms [13]. In Europe, litter moisture has been linked to the development of FPD in broiler chickens and turkeys [14–17, 20, 22]. It appears that the wetter the litter is, the more likely that FPD will develop. Although Japan is a country of high humidity throughout the year, the association between litter moisture and FPD has not been studied. The purpose of the present study, therefore, was to investigate the effect of litter moisture on the development of FPD among Japanese broiler chickens.

The experiment was conducted from May to July, 2011, at

a farm located near Taka Pass (alt. 722 m) in Tarumizu, Kagoshima Prefecture, which has been consistently affected by FPD. The farm consisted of four windowless, poultry houses arranged in a row. Each house (825 m²/house) contained 18,500 chicks on regular litter (litter moisture varied from 30.9% to 56.5%; referred to as “wet-litter” in this study). In the wet-litter house, water was sprayed onto the floor surface as necessary (1–3 times/week, until 35 days of age; 9 times in total) to maintain the humidity and to prevent dust in the air of the house. Litter was turned as necessary (1–3 times/week) until 28 days of age. The water spray and litter treatment were done routinely according to the management manual of the farm. One of the end houses was used in the present experiment. Adjacent to this end house, an additional windowless poultry house was built to rear another flock of chicks on low-moisture litter (litter moisture varied from 15.1% to 40.0%; referred to as “dry-litter” in this study). This dry-litter house was smaller (14 m²/house), but was designed to operate under conditions identical to the wet-litter house, except for litter condition. In the dry-litter house, water was not sprayed to keep the floor humidity low, and litter was turned frequently (3–4 times/week) until 49 days of age. In both houses, the same sawdust (100%) with a depth of about 10 cm was used as the litter material, and the same compound feed (starter, pre-grower, grower and finisher; Marubeni Nisshin Feed Co., Ltd., Tokyo, Japan) was used in equal amounts. Water supply by nipple drinker, heating by a liquefied petroleum gas system and a vaccination program were also equally given to chicks in both houses.

Commercial broiler chicks (Chunky) from the same lot were used in this study. To achieve equal stocking densities, 18,500 day-old chicks (22.4 birds/m²) were placed in the wet-litter house, whereas 315 day-old chicks (22.5 birds/m²) were placed in the dry-litter house on the same day.

Litter samples were collected once every week, excluding the day of water spray and litter turning, from 5 different sites

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per house and pooled before measurement. The litter moisture content was determined by the loss of weight on drying. In brief, the pooled litter was weighed, dried for 15 min in an Electric Drying Oven (Model: FS-405, Advantec Co., Ltd., Saijyo, Japan) and weighed again. The decrease in weight was recorded as moisture content (%).

FPD was scored every week on a 4-point scale according to a previously reported method [13]. In brief, the footpad lesions were assigned to one of 4 classes: score 0, no lesions; score 1, lesions in some areas (<50%) of footpad; score 2, lesions wide areas (between 50% and 100%) of footpad; score 3, lesions throughout wide areas of footpad and the surroundings regions. The mean score of FPD was calculated as the cumulative total of the lesion scores divided by the total number of birds examined. FPD score was determined for 100 birds randomly selected from the wet-litter house and 30 birds from the dry-litter house. In addition to these birds, 15 birds were randomly selected from each house at 21, 28 and 35 days of age, and after recording the FPD score and identifying each bird by marking the back feathers and attaching uniquely numbered leg bands, they were moved from the wet-litter house to the dry-litter house or vice versa. These birds were then reared, and the FPD score was recorded once every week until 49 days of age. FPD scores were compared between the groups statistically by *t*-test.

Examples of typical footpad lesions found in broilers reared on dry litter or wet litter for 7 weeks (49-day-old) are shown in Fig. 1. Changes in the mean FPD score and litter moisture content in broilers aged up to 49 days are shown in Fig. 2. The litter moisture increased with time from 30.9% to 56.5% in the wet-litter house and from 15.1% to 40.0% in the dry-litter house. The litter moisture was noticeably lower in the dry-litter house than in the wet-litter house. Among birds reared on wet litter, FPD first developed at 14 days of age, and the mean FPD score increased dramatically and progressively from 21 days of age, reaching 2.92 at 42 days. In the flock reared on dry litter, by contrast, FPD was first observed at 28 days of age, and the mean FPD score remained low up to 49 days of age (0.70). Between 21 and 49 days of age, FPD scores were significantly different between the groups ($P < 0.01$).

Figure 3 (A) shows changes in the mean FPD score for birds that were moved from the dry-litter house to the wet-litter house. The FPD score started to increase immediately after relocation, and at 2 weeks after relocation, FPD scores were comparable between birds moved at 21 or 28 days of age and those reared on wet litter throughout the study period. Among birds moved from dry litter to wet litter at 35 days of age, the FPD score increased relatively slowly after relocation and was still 1.33 at 49 days of age, although this score was still higher than that of the birds reared on dry litter only.

Changes in the mean FPD score among birds that were moved from the wet-litter house to the dry-litter house are shown in Fig. 3 (B). The mean FPD score of 15 birds selected at 21 days of age was 1.53 at the time of relocation. After relocation, the score started to decrease and was 0.88 at 49 days of age. Similar changes were observed among



Fig. 1. Typical footpad lesions in broilers reared on dry litter (A) and wet litter (B) for 7 weeks (49-day-old). The mean FPD scores, 0.70 on dry litter (A) and 2.58 on wet litter (B), differed significantly ($P < 0.01$).

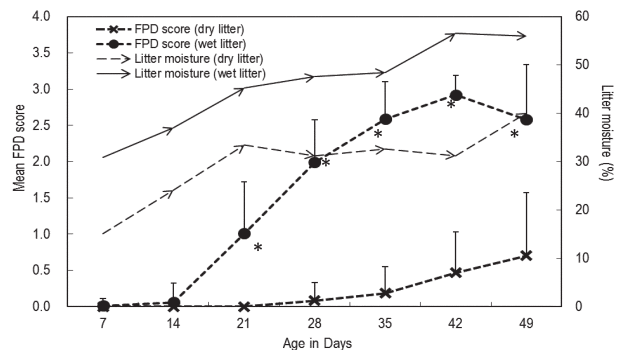


Fig. 2. Changes in litter moisture and FPD score. Litter moisture in the wet-litter house increased from 30.9% to 56.5%, whereas that in the dry-litter house changed 15.4% to 40.0%. The mean FPD scores on wet litter increased from 21 days of age and differed significantly ($* P < 0.01$) from those on dry litter.

birds that were relocated at 28 days of age, and the FPD score decreased slightly, reaching 1.60 at 49 days. Among birds moved at 35 days of age, however, the FPD score was already high (2.40) at the time of relocation and thereafter showed a similar pattern to that of birds reared on wet litter only.

This is the first study to address the association between litter moisture and the development of FPD in commercial farms in Japan, rather than in a laboratory environment. FPD has been described as contact dermatitis, because it develops in contact with litter that is high in moisture content [11]. It has been demonstrated that daily 8-hr contact with wet litter can cause FPD lesions on the skin of the foot in growing turkeys [22]. In the present study, broilers reared on wet litter developed FPD from an early age, and it progressed severely. When these broilers were moved to dry litter, however, the disease progression was suppressed or delayed depending on the age of transfer. These results suggest that FPD can be

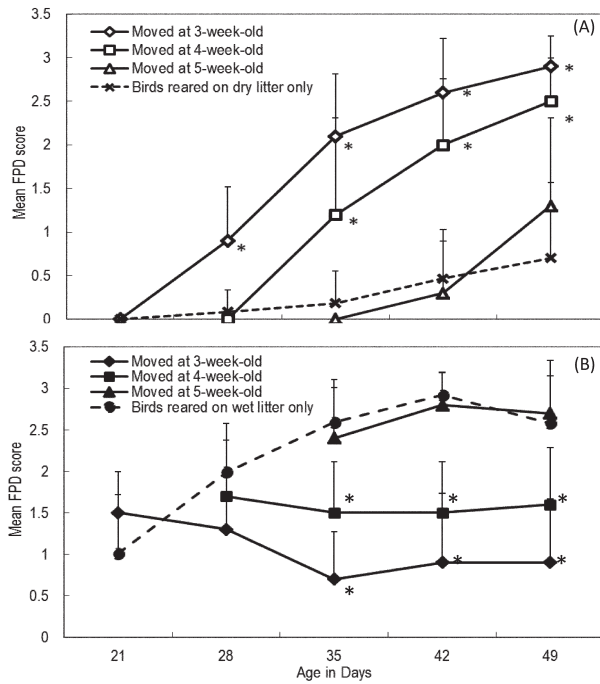


Fig. 3. (A) Changes in FPD score in broilers moved from dry litter to wet litter. After relocation at 21 and 28 days of age, the mean FPD score started to increase with an immediate with significant difference ($* P < 0.01$) from those on dry litter. (B) Changes in FPD score in broilers moved from wet litter to dry litter. After relocation at 21 and 28 days of age, the mean FPD score started to decrease or remained at the initial level with significant difference ($* P < 0.01$) from those on wet litter.

treated or at least improved by changing the litter conditions, even after the visible onset of disease.

Martland [14] and Mayne [16] also reported that FPD lesions are alleviated by replacing wet litter with dry litter or by transferring birds from wet to dry litter. In the report of Martland [14], severe FPD lesions were recovered quickly and completely when the birds were transferred from wet to dry litter even at 7 weeks of age. In our present study, although recovery of FPD lesions among birds transferred from wet to dry litter was observed, the recovery was slight. Although we do not know the reasons for this difference in results, rearing conditions in the dry-litter house in our experiment might be worse because bird density was about twice as high as that in the study of Martland [14], and the moisture content had increased to 40% by the end of the experiments. When birds are reared on dryer litter at a lower density, it is possible that they might recover more quickly. To discuss more in detail, however, it will be necessary to gather more information about litter contents, bird density and climate condition, such as temperature and humidity, for both cases.

We previously reported that FPD can develop among chicks aged 1 week in broiler farms [13]. In our present study, when FPD-free birds (score 0) that had been reared on dry litter for 21 or 28 days were moved to wet litter, the first sign

of FPD was already evident after 7 days of relocation and became severe after that. In FPD-free birds (score 0) that were moved to wet litter at 35 days of age, however, the development of disease was relatively suppressed. These results indicate that although broilers are prone to FPD when they are younger, they may acquire age-dependent resistance against FPD after 35 days of age. To our knowledge, this finding of age-dependent resistance against FPD has not been reported before and also suggests that delayed exposure to litter wetness may lead to delayed or reduced severity of FPD lesions. de Jong *et al.* [5] reported that the severity of FPD lesions decreased as age to slaughter increased. For explanation of the result, they discussed on litter quality improvement due to depopulation or contact condition of feet with litter, but not on age-dependent resistance of chickens. Our observations that FPD lesions recover or show suppressed progress when the litter condition is improved and that age-dependent resistance exists against FPD are especially noteworthy for the control of FPD.

FPD is undoubtedly an important disease in the poultry industry that is associated with considerable economic loss. Recently, Hashimoto *et al.* [12, 13] reported that the prevalence of FPD poses a serious risk to Japanese broiler production and that FPD severity is positively correlated with the condemnation rate and negatively correlated with the live weight and leg meat yield. They suggested that controlling FPD might play an important role not only in reducing condemnations but also in improving live weight and leg meat yields.

Litter improvement is a critical step we should take to control FPD. Yet, litter management is a challenging task in Japan, owing to the humid climate. Air conditioning is useful to keep the humidity low, but it may interfere with temperature control in the poultry house. In addition, some poultry managers prefer a humid environment, because they believe that dry litter is likely to generate dust, which may increase the likelihood of the airborne transmission of pathogens, such as *Escherichia coli*. Often, litter moisture can be reduced simply by turning the litter, because only the upper layers are likely to be high in moisture. Because turning litter in a humid poultry house is laborious and can be stressful to the birds themselves, however, this practice is not encouraged in the field.

Alternatively, modification of feed composition has been proposed to adjust the water content of poultry excreta [7–9]. This option also seems challenging and needs some consideration, because re-formulation of feed is costly and may affect meat quality and yields. Litter materials have also been examined as a contributing factor in the development of FPD [3, 6, 16]. Mendes *et al.* [18] compared two kinds of litter—wood shaving and sawdust—on the development of FPD. Their results showed that litter type did not have any effect on litter humidity, although the wood shavings significantly influenced FPD. In addition to humidity, litter materials also should be considered as an important factor in the control of FPD. Enteric disease control is another important aspect in good litter management, because diarrhea will increase the moisture content of litter.

In summary, the results of the present study clearly demonstrate that litter moisture is crucial to the control of FPD. A multifactorial approach to litter management would be essential to achieve a balance with the many other factors involved in poultry management.

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