Effect of substrate during early rearing on floor- and feather pecking behaviour in young and adult laying hens

Einfluss des Einstreusubstrats in der frühen Aufzuchtphase auf das Boden- und Federpicken bei jungen und adulten Legehennen

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Introduction

Feather pecking is a major welfare problem in laying hens, with hens pecking at and pulling feathers from conspecifics causing pain and injuries, and which may lead to cannibalism and increased mortality in a flock. Besides a higher flock mortality it may also increase food consumption and thus also has economic consequences for the farmer. Feather pecking in laying hens is a multifactorial problem. Many factors may influence the development of feather pecking, such as light, food, the occurrence of stress and the availability of substrate (e.g., Blokhuis and Wiepema, 1989; Dixon, 2008; Lamton et al., 2010).

It has been shown that conditions during the rearing period may have an effect on feather pecking during rearing as well as in lay (Blokhuis and Vanderhaar, 1989; Norgaard Nielsen et al., 1993; Johnsen et al., 1998; Van de Weerd and Elson, 2006; Dixon, 2008; Bestman et al., 2009). In addition, it has been suggested that especially the conditions during the early rearing period may play a role in the development of feather pecking at a later age (Johnsen et al., 1998; Gunnarsson et al., 1999; Chow and Hogan, 2005; Jensen et al., 2006; Dixon, 2008), although others showed that current environmental conditions may be more important than early experience (Nicol et al., 2001). During the early rearing period several behaviors are developing, including foraging and dust bathing (Hogan and Van Boxel, 1993; Johnsen et al., 1998; De Jong et al., 2009). Providing chicks with environmental conditions that stimulate the development of these key behaviours may prevent the development of unwanted behaviours like feather pecking. This is in particular suggested for substrates that promote foraging (e.g., Blokhuis and Vanderhaar, 1989; Huber-Eicher and Wechsler, 1997; 1998). Huber-Eicher and Wechsler (1997) showed that providing chicks with a dustbathing substrate (sand) did not prevent feather pecking, but providing sand as well as long straw (dustbathing and foraging substrate) did prevent feather pecking.

In commercial free-range and aviary systems, laying hens are often confined on the raised slatted area or in the system during the first 2–5 weeks (dependent on the policy of the individual farmer) with either chick paper or mesh matting (plastic wire with a small diameter for chick housing) on the floor. If the early rearing period is important in guiding the pecking behaviour of a chick, this may imply a risk for the development of feather pecking later in life. In the absence of a suitable pecking substrate, chicks may redirect their pecking behaviour to other birds. If this preference is permanent, there may be a substantial risk for the development of feather pecking. Although results of Johnsen et al. (1998) and Huber-Eicher and Wechsler (1997) indeed gave evidence for this hypothesis, others (Nicol et al., 2001) could not confirm this and further research to the effect of substrate in early rearing on the development of feather pecking is therefore justified.

The objective of this experiment was to study whether early provision of substrate would permanently direct the pecking behaviour towards the substrate and would reduce the risk of feather pecking later in life. Either sand or wood shavings were used as a substrate. Previous research has shown that laying hens had a preference to forage in wood shavings (De Jong et al., 2007), but they preferred peat (De Jong et al., 2007) or sand (Van Lier et al., 1990; Sanotra et al., 1995) for dust bathing. A preceding pilot study with young laying-hen chicks in a pen where they had access to sand and wood shavings, showed that most chicks were preferring the wood shavings (De Jong et al., 2009). In addition, results of Johnsen et al. (1998) indicated that sand was less effective in preventing feather pecking than sand and straw. We therefore hypothesised that wood shavings would be more effective in stimulating floor pecking and preventing feather pecking than sand.

Materials and Methods

Animals and housing

On day 1 1440 non beak trimmed day-old chicks (Lohmann Brown Lite) were obtained from a commercial hatchery and randomly divided over 60 pens (L × W × H 1.50 × 1.0 × 2.30 m, 24 chicks per pen). Pens were located in two identical units. Every unit had two rows of fifteen pens separated by wire mesh. Half of the replicates per treatment was randomly assigned to a pen within one unit. A sheet of cardboard was placed against the mesh so that the substrate could not spread to neighbouring pens.

Until 21 days of age, the chicks were confined on the raised slatted area (50 × 100 cm, height 52 cm). Afterwards they got access to the entire pen. Either mesh matting (plastic wire with a a small diameter, used for housing of chicks), chick paper, wood shavings on chick paper, or sand on chick paper were provided on the raised slatted area (Table 1).
In the treatments with substrate, a layer of 1 cm of substrate on chick paper was provided.

After 21 days of age, all chicks were given access to the entire pen, and all chicks obtained access to either sand or wood shavings in the substrate area (substrate area dimensions 100 × 100 cm) and six treatment groups were created (see Table 1 for treatment groups). The chick paper or mesh matting were removed from the raised platform. Because the chicks were too young to fly onto the raised platform a ramp was provided which was removed at 8 weeks of life. Three nipple drinkers were available from the raised slatted area. Until 21 days of age, the feed was supplied on the raised slatted area. As of 21 days of age feed was provided in the substrate area. Food and water were provided ad libitum. Above the raised slatted area two perches were placed at 47 and 90 cm height.

At the start of the laying period (17 weeks), the groups were reduced to 12 hens per pen using a random selection of birds. Nest boxes could be accessed from the raised platform, and were available from 20 weeks of age onwards. The experiment was terminated at 40 weeks of age.

On days 1–2 24 hours of light were provided. This was reduced to 9 hours of light from 5 to 16 weeks of age. From age 17 weeks the light duration was increased by one hour per week to 14 hours of light at 21 weeks of age. The light intensity was about 30 lux on day 1. This was reduced to 5 lux from 5 to 16 weeks of age. From 17 weeks of age, the light intensity increased to 10–15 lux at the substrate floor (20 lux on the raised slatted area). Lights were on from 7.30 am. Because little feather pecking was observed, light intensity was increased to a maximum capacity of 20 lux a floor level at 29 weeks of age in an attempt to stimulate pecking behaviour (Rwu et al., 2007). In addition, roof windows were uncovered allowing natural light into the barn. This resulted in increased lighting levels of 10–30 lux on cloudy days and another 5–15 lux on sunny days.

A commercial vaccination scheme was applied. Since the contrast between wood shavings and sand was relatively small due to mixing with manure, as of 9 weeks of age substrate (sand/wood shavings) was partly replaced by new substrate every 4 weeks in the week after the behavioural observations.

Weights and mortality

Mortality was recorded daily with reason, if known. Animals were weighed on day 0, at 19 and at 40 weeks of age (the end of the experiment), using a group weighing for each pen.

Behavioural observations

Rearing. All observations took place between 8.30 and 16.30 h. On days 5, 8 and 14 the number of chicks eating/drinking, floor pecking, gentle feather pecking (gently pecking at the down or feathers of another bird, not leading to feather damage), severe feather pecking (pecking and pulling at the down or feathers of another bird, often leading to feather damage and a reaction of the pecked bird), aggressive pecking (often single pecks directed at the neck/head), displaying comfort behaviour (dust bathing, stretching, preening) were recorded. These counts were conducted twice in the morning and twice in the afternoon. In addition, for two randomly selected pre-marked chickens the frequency of pecking at down or feathers of another bird was recorded during one minute, once per observation day. Behaviour was also scored in weeks 4, 8, 12 and 16. By observation day, again, the number of animal performing a certain behaviour was counted as described above. In addition, it was scored after the counts of the different behaviours if gentle or severe feather pecking was observed in a pen during a one minute observation per pen.

Production period. In the production period behavioural observations were done at 20, 24, 28, 32, 36 and 40 weeks of age. The number of animals performing a certain behaviour was counted by direct observations as described above for the rearing period. In addition it was determined if gentle and severe feather pecking occurred in the pen, during an observation period of one minute. Also the frequencies of gentle and severe feather pecking were determined for two randomly selected, pre-marked hens over a period of one minute as for the rearing period. As the incidence of feather pecking turned out to be very low during the whole experiment, at 40 weeks of age an additional observation on feather pecking bouts was done. During a 10 minute session all incidences of severe and gentle feather-pecking bouts were recorded, where a bout was considered terminated when the behaviour was no longer observed for at least 5 seconds. It was separately noted if gentle feather pecking was directed at dustbathing hens.

Feather damage

At the end of the rearing period (16 weeks of age), and at the end of the experiment (40 weeks of age), feather damage was determined according to Table 2 for the following body parts: comb, head, neck, belly, back, wings, tail, thigh, shin.

Statistical analysis

Counted data were converted to fractions of animals per pen. For the fractions and frequencies of floor-directed pecking ranks were assigned within units. The F-test was used to determine whether there was a treatment effect, where observation session, unit and treatment and interactions were included. Non-significant interactions were removed from the final model. When a significant treatment

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**Table 1. Treatment regimen (n = 10 pens per treatment)**

**Behandlungen (n = 10 Abteile je Behandlung)**

<table>
<thead>
<tr>
<th>Treatment code</th>
<th>Until day 21 of age</th>
<th>After 21 days of age</th>
</tr>
</thead>
<tbody>
<tr>
<td>Paper – wood shavings (PW)</td>
<td>Chick paper</td>
<td>Wood shavings</td>
</tr>
<tr>
<td>Paper – sand (PS)</td>
<td>Chick paper</td>
<td>Sand</td>
</tr>
<tr>
<td>Mesh – wood shavings (MW)</td>
<td>Chick mesh matting</td>
<td>Wood shavings</td>
</tr>
<tr>
<td>Mesh – sand (MS)</td>
<td>Chick mesh matting</td>
<td>Wood shavings</td>
</tr>
<tr>
<td>Wood shavings (W)</td>
<td>Wood shavings</td>
<td>Sand</td>
</tr>
<tr>
<td>Sand (S)</td>
<td>Sand</td>
<td>Sand</td>
</tr>
</tbody>
</table>

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effect was found a t-test was used for subsequent pairwise comparisons between treatments. The binary data (feather pecking or not) were analysed using the number of positive scores per treatment. These data were analyzed using a GLM procedure with a binomial distribution and logit-link. Session, unit and treatment and interactions were included as factors in the model. Non-significant interactions were removed from the final model. The analysis of feather pecking bouts was done with regression analysis with a Poisson distribution and log-link. Unit and treatment, and interactions were included in the model. Non-significant interactions were removed from the final model. When a significant effect was found, pairwise comparisons using a t-test were subsequently performed on ranks. Feather scores per pen were analyzed using an analysis of variance with treatment as factor and additional pairwise comparisons between treatments using a t-test. All analyses were performed with Genstat (v.12, VSN International, Hemel Hemstead, UK).

<table>
<thead>
<tr>
<th>Score</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>Plumage smooth</td>
</tr>
<tr>
<td>1</td>
<td>Feathers rough</td>
</tr>
<tr>
<td>2</td>
<td>Feathers broken</td>
</tr>
<tr>
<td>3</td>
<td>Feathers shaggy</td>
</tr>
<tr>
<td>4</td>
<td>Balding</td>
</tr>
<tr>
<td>5</td>
<td>Bold/skin healthy</td>
</tr>
<tr>
<td>6</td>
<td>Skin damage</td>
</tr>
<tr>
<td>7</td>
<td>Skin mildly wounded</td>
</tr>
<tr>
<td>8</td>
<td>Skin seriously wounded</td>
</tr>
</tbody>
</table>

Results

Animal weights and mortality

There were no significant differences between the treatments in body weight at placement, at 19 and 40 weeks of age (data not shown). Average mortality was 2.6% in the rearing period and 1.53% during the laying period, and not significantly different between the treatments for the rearing as well as the laying period. There was no mortality due to feather pecking.

Behavioral observations

Early rearing until 21 days of age. Figure 1 shows increasing floor pecking over time in early rearing. A significant difference in floor pecking was found between treatments at 5, 8 and 14 days of age (all P < 0.000). At 5, 8 and 14 days of age the percentage of animals engaged in floor pecking was significantly higher on sand, wood shavings and paper (PS and PW) compared with mesh (MW and MS) (P < 0.05 at least). Also, at 5 days floor pecking was higher on wood shavings (W) compared to paper (PS and PW) (P < 0.05). At 8 and 14 days of age, floor pecking was higher on sand compared to wood shavings and paper (PW and PS) (P < 0.05).

There was also a significant effect of the treatments on the number of animals engaged in comfort behaviours on day 5 (P < 0.000). The percentage of chicks performing comfort behaviors was higher for paper (7.9 ± 1.1% to 8.9 ± 1.0% for PW and PS) compared to sand (5.2 ± 0.9%), wood shavings (5.8 ± 0.7%) and mesh (MW 5.2 ± 1.0% and 5.5 ± 1.0% MS) (P < 0.05).

Results of counts of floor pecking of two randomly-chosen animals per cage for one minute are shown in Table 3. At day 5, chicks on wood shavings pecked significantly more at the floor as compared to the other treatments (P < 0.05). At 8 days of age, pecking was highest in PW and this dif-
fered significantly from the mesh and wood shavings treatments (P < 0.05), but not from PS and sand. At 14 days of age, a similar trend was found: the frequency of floor pecking was higher on paper, wood shavings and sand than on mesh matting, but differences were not significant (Table 3).

**Rearing period from 21 days of age onwards.** Only at 4 weeks of age a significant treatment effect was found for the number of animals engaged in floor pecking. For treatments which started on paper and were later kept on wood shavings or sand the percentage of birds pecking at the floor was significantly lower than birds kept permanently on sand or wood shavings, or that were first kept on mesh and later on sand or wood shavings (PW 4.1 ± 1.3%; PS: 4.6 ± 1.5%; W: 6.4 ± 1.7%; S: 7.9 ± 2.1%; MW: 5.6 ± 1.7%; MS: 7.6 ± 2.0%; P < 0.05). For other behaviours, no treatment effect was found at 4 weeks of age (data not shown). In addition, there was no significant treatment effect for any behaviour at 8, 12 and 16 weeks of age (data not shown).

Significant treatment effects were found for pens where gentle feather pecking was observed at 4 and 16 weeks age (Figure 2). The number of pens with severe feather pecking observed showed a tendency for a treatment effect at 8 and 16 weeks of age (P < 0.10; Figure 2). Pairwise comparisons showed that at 4 weeks of age gentle feather pecking occurred more in the treatments that first had mesh (MW and MS) and in treatments that were first kept on paper (PW and PS) compared to treatments that are kept permanently on either sand or wood shavings (S and W) (P < 0.05). At 16 weeks of age the differences were less clear, but gentle feather pecking was observed less frequently in the MS treatment compared with MW and PW (see Figure 2). Because severe feather pecking did not occur in a number of treatments, pairwise comparisons could not be performed (see Figure 2).

**Production period.** The number of birds showing gentle or severe feather pecking, aggressive pecking and dust bathing was low, such that no reliable analysis could be performed. Other behaviours (eating/drinking, floor pecking, comfort behaviour) only showed a significant treatment effect for floor pecking at 40 weeks of age (P < 0.001). At this age, significantly more birds were floor pecking in MW and MS (7.8 ± 1.2% and 7.9 ± 1.5%) than in W, PW, PS and S (3.6 ± 0.6%, 6.9 ± 1.1%, 2.7 ± 0.4%, 2.7 ± 0.4% respectively).

No treatment effects were found for the number of pens with gentle feather pecking behaviour during production (data not shown). The number of pens with severe feather pecking was insufficient to allow a statistical analysis (data not shown). Also, the counts of feather pecking in two randomly selected animals per cage during one minute generated low numbers, which could not be analyzed (data not shown).

At the end of the experiment at 40 weeks of age feather pecking bouts were scored (Figure 3). In general, the frequency of gentle and severe feather pecking bouts were low. A significant treatment effect was found for gentle feather pecking at dust bathing birds (P < 0.05) and a tendency for a difference for the sum of all gentle pecking bouts. Pairwise comparisons showed that significantly more feather pecking bouts during dust bathing in PW compared to W (P < 0.05, Figure 3).

**Feather damage.** From all single scores an index score was calculated as the sum of all individual scores per body part. The average index scores for the rearing period are just below or above 1 indicating that feather damage was low. Yet there was a significant treatment effect (P < 0.05), where feather damage in MS was higher than in the other treatment groups (P < 0.05; Table 4). During the production period feather damage increased, as can be seen from the increase of the index (Table 4). Feather damage in laying differed between different body parts. Feather damage was highest for the breast for all treatments. All other body parts had a score less than 1.5 on average. There were no significant differences between treatments.

**Discussion**

The expectation was that chicks provided with substrate in early rearing, in particular wood shavings, would direct their pecking behaviour more at the floor as compared to chicks on paper and mesh matting. Also, that these differences in behaviour persist throughout rearing and laying. Finally, it was hypothesised that stimulating floor pecking in early rearing would result in less feather pecking behaviour at a later age. Chicks on wood shavings and sand both indeed showed more floor pecking during early rearing, however, these pecking preferences seemed to fade out during later rearing and did not result in differences in feather pecking behaviour between the treatment groups during laying.

The results showed that in particular at a very early age, at day 5, wood shavings were attractive as pecking substrate, whereas with increasing age sand became more attractive. This confirms the findings of an earlier pilot study, where chicks that could chose between sand and wood shavings as pen substrate spent most time in the section with wood shavings, but showed an increasing time spent on sand until 14 days of age (De Jong et al., 2009). It is not fully clear why wood shavings are more attractive as

<table>
<thead>
<tr>
<th></th>
<th>Average frequency of floor pecking per minute (± sem)</th>
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<tbody>
<tr>
<td></td>
<td>MW</td>
</tr>
<tr>
<td>5 days</td>
<td>0 ± 0.4a</td>
</tr>
<tr>
<td>8 days</td>
<td>0.6 ± 0.4a</td>
</tr>
<tr>
<td>14 days</td>
<td>2.4 ± 1.6</td>
</tr>
</tbody>
</table>

Note: Different characters within a row indicate significant differences between treatments (P < 0.05).
pecking substrate as compared to sand at a very early age. Sand is a preferred substrate for dustbathing behaviour (Van Leeuwen et al., 1990; Sanotra et al., 1995; De Jong et al., 2007) and the development of this behaviour may play a role. But with increasing age sand becomes mixed with manure and food particles and may therefore become more attractive as a foraging substrate. This may also explain the increased floor pecking at chick paper with age. Chicks on paper showed as much floor pecking behaviour as chicks on wood shavings and sand from day 8 onwards. After a few days chick paper is covered with a thin layer of manure and food particles that may be attractive as pecking substrate.

However, despite the clear differences in floor pecking behaviour between the treatments in early rearing, only at four weeks of age a difference in floor pecking behaviour was observed but not at a later age. More floor pecking was observed in the treatments that were first housed on mesh matting and sand or wood shavings than on paper. Chickens that have always been housed on substrate may still prefer to direct their peckings to the floor, while chicks first housed on mesh matting may show catching up behaviour. It is unclear why floor pecking is less in chicks first housed on paper. Differences in early rearing apparently have no effect on pecking substrate early in life prevents feather pecking at a later age (Huber-Eicher and Wechsler, 1997; Johnsen et al., 1998; Chow and Hogan, 2005). Johnsen et al. (1998) showed that laying hens reared on wire during the first 4 weeks and that were subsequently housed on sand and straw, showed significantly more feather pecking in rearing and laying as compared to laying hens housed on sand until 4 weeks of age or that had always been housed with sand and straw as substrate. However, frequencies of severe feather pecking were very low, in rearing as well as in laying. The results of the present experiment thus do not confirm earlier studies that suggest that providing chicks with adequate pecking substrate early in life prevents feather pecking at a later age (Huber-Eicher and Wechsler, 1997; Johnsen et al., 1998; Chow and Hogan, 2005).
et al. (2001), showing that substrate, even if it is provided during a period as short as 10 days, may be protective. In addition, the results of Nicol et al. (2001) showed that pecking preferences of chickens housed on wire could be changed when adequate substrate was provided, and that there were no indications that especially substrate in the early rearing period is important for preventing feather pecking.

The current experiment differs from earlier experiments (Huber-Eicher and Wegsigh, 1997; Jøhnson et al., 1998; Chow and Hogan, 2005) in that we observed very low frequencies of gentle as well as severe feather pecking behaviour. Attempts to stimulate feather pecking by increasing the light intensity as much as possible in the house were not successful in stimulating feather pecking behaviour. Also with measuring pecking bouts during a longer time span at the end of the experiment frequencies were very low and not different between treatment groups. In this experiment we replaced the substrate every four weeks in order to maintain the contrasts between sand and wood shavings. This may have increased floor-pecking motivation in all groups, thereby preventing the occurrence of feather pecking as providing enrichment material can help to prevent feather pecking (e.g., Dixon, 2008). As almost no feather pecking was observed in all groups, possible differences in feather pecking between the treatment groups could not be measured and no firm conclusions based on the results of the current experiment could be drawn.

At the end of the experiment there were no detectable differences between treatment groups in the quality of the plumage, despite significant differences at the end of rearing where the MS group had higher scores (more damaged feathers) as compared to the other treatment groups. The higher feather damage in the MS group seems to be in line with the observation of more severe pecking in this group at 16 weeks of age. The absence of significant differences at the end of the experiment at 40 weeks of age was in line with the behavioural observations showing that there were no differences in (severe) feather pecking in the laying period.

In conclusion, this study shows that more floor pecking occurs during the early rearing period when rearing pullets are housed on wood shavings, and that from day 8 onwards chicks housed on paper and sand also showed more floor pecking as compared to chicks on mesh matting. Only at four weeks of age differences in floor pecking and gentle feather pecking were observed, with lowest levels of gentle feather pecking in groups housed on mesh matting during early rearing. However, these differences were not seen
further in rearing and in laying. Providing substrates such as sand and wood shavings did not show major differences, so as to prefer one over the other. The results of the present experiment therefore seem to support the conclusions of NICOL et al. (2001), that laying hen behaviour is generally flexible and strongly influenced by the current substrate. The current results are in contrast with earlier studies indicating that substrate in early rearing may be protective for feather pecking (CHOW and HOGAN, 2005; HUBER-EICHER and WECHSLER, 1997; JOHNSON et al., 1998), although, due to the low levels of gentle and severe feather pecking in all treatment groups in the current experiment, it would be good to support this with additional research.

Acknowledgements

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Summary

An experiment was conducted to test the hypothesis that providing adequate substrate to laying hens during early rearing stimulates pecking to the floor and reduces feather pecking when adult. Laying hens were either provided with wood shavings or sand from day 1 onwards or from day 21 onwards. Chicks without substrate were either reared on mesh matting or chick paper until day 21. Behaviour was observed during rearing and the production period. Moreover, feather damage was scored at the end of rearing and at 40 weeks of age. Results showed that providing substrate in early rearing indeed stimulated floor pecking. At four weeks of age, more gentle feather pecking was observed when previously housed on chick paper or mesh matting as compared to continuous housing on sand or wood shavings. However, initial differences in floor- and feather pecking disappeared with age and only some minor effects were observed at the end of rearing and during production. At the end of the rearing period, only the groups that were first housed on mesh matting and from three weeks of age housed on sand, showed significantly more feather damage. No differences in feather damage between the treatments were found at 40 weeks of age. This experiment showed that floor pecking was stimulated in early rearing when providing substrate. Although the absence of substrate at an early age seems to stimulate gentle feather pecking in early rearing, these effects were not clearly visible at a later age. It is suggested that hens may redirect their early pecking preferences when adequate pecking substrate is provided at three weeks of age.

Key words

Laying hen, feather pecking, rearing, substrate

Stichworte

Legehennen, Federpicken, Aufzucht, Einstreusubstrat

References


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