The role of loose feathers for the development of feather pecking in laying hens

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1 **Role of loose feathers on the development of feather pecking in laying hens**

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9 Short title: **Loose feathers and feather pecking**

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Abstract. 1. The effect of the presence of loose feathers (on the floor) on the behaviour and plumage condition of laying hens (Lohmann Silver, LS) was studied during the rearing and laying periods.

2. From 1-d-old, 60 birds in each of 4 straw-bedded pens (n=240 in total) with 6.5 birds/m² were either kept under conventional rearing and management conditions (CT: control group with feathers on the floor; n=120) or in pens from which the feathers were collected from the floor 4 times/week (FR: feathers removed; n=120). Fifty birds from each of these 4 groups (n=200 in total) were randomly selected at the age of 16 weeks and allocated to 4 identical pens in a poultry layer house (PH; with perches and 1/3 slatted floor) with access to an outside area (winter garden, WG) at a stocking density of 6 birds/m² in both PH and WG.

3. Observations on feather pecking and other behaviours (feeding, drinking, preening, standing, sitting, foraging, moving and dust bathing) were carried out at 8 ages: 6, 10, 15 (rearing period), 20, 25, 30, 35 and 40 weeks (laying period). Feather scoring was carried out at 15, 32 and 39 weeks of age.

4. There were no differences in feather pecking rates, forms (gentle, severe and aggressive pecks) as well as in the plumage condition between groups at the end of the rearing period.

5. Birds in the **FR** group exhibited lower rates and less severe feather pecking during the laying period. Accordingly, birds in the control group had worse feather condition at 32 and 39 weeks of age. Feather pecking rates within groups were, in general, greater in the afternoon compared to the morning periods. Birds in the control group were more active in walking.

6. Wings, rump, tail and back were the main targets for feather pecking. The majority of feather pecking occurred on the floor (66 %) followed by feeding area (26 %), perches (4 %) and slats (4 %).

7. Our results suggest that loose feathers on the floor may play an important role in the development and severity of feather pecking behaviour in laying hens and support the hypothesis (McKeegan and Savory 1999) that feather pecking can be viewed as redirected foraging behaviour.

INTRODUCTION

Feather pecking is interpreted as an abnormal behaviour where laying hens peck the feathers of conspecifics, damage the plumage or even injure the skin. It is considered as one of the most widespread and serious problems of today’s poultry production when hens are kept under commercial conditions (Savory, 1995; Blokhuis *et al.*, 2000). It reduces welfare in the recipient birds, because it has been suggested that having feathers pulled out is perceived as painful (Gentle and Hunter, 1990) and can lead to cannibalism (Allen and Perry, 1975). Moreover, it increases economical losses due to increased mortality, reduction in egg production (El-Lethy *et al.*, 2000), increased food consumption (Leeson and Morrison, 1978), and is also associated with increased (chronic) fear (Hughes and Duncan, 1972; Ouart and Adams, 1982). Johnsen *et al.* (1998) emphasised the importance of early rearing conditions (litter substrate) on the development of feather pecking behaviour, of which the presence of loose feathers on the floor in early life may affect subsequent pecking behaviour. Feather eating has been observed in commercial layers (Savory and Mann, 1997; Harlander-Matauschek

and Bessei, 2005). Pullets prefer to eat shorter semiplumes (< 10 cm) rather than longer ones, and once feather eating has become established, a shortage of loose feathers on pen floors may cause a redirected pecking and eating of feathers from other birds (McKeegan and Savory, 1999). Similarly, Forkman (2003) reported that feather pecking can be viewed as foraging behaviour in which the birds first learn to peck at loose feathers on the floor and then develop into proper feather pecking when there are no more feathers available. The objective of this study was to investigate the effect of feather presence or absence on the floor on various behaviours of LS laying hens with emphasis on feather pecking and plumage condition.

MATERIALS AND METHODS

Birds and housing condition

A total of 240 1-d-old layer hen chicks (Lohmann Silver, LS) were either kept in two pens under conventional rearing and management conditions (CT; n=2 x 60) or in two pens from which the feathers were collected from the floor 4 times/week (FR; n=2 x 60). Fifty birds from each of these 4 groups (n=200 in total) were randomly selected at the age of 16 weeks and allocated to 4 identical pens in a poultry layer house (PH; with perches and 1/3 slatted floor, the remaining part was deep litter area with straw) with unrestricted access to an outside area (winter garden, WG, littered with shredded tree bark) at a stocking density of 6 birds/m² in both PH and WG. All selected hens remained in their original rearing group. The treatment in the laying period (presence or absence of feathers on the floor in the PH and WG) was the same for all birds as in the rearing period. Each group

had access to 4 nests (60 cm x 30 cm x 30 cm). Four perches were placed 50 cm above the slats which allowed 15 cm space on the perch for each bird. Two round feeders were fixed 20 cm above the floor and 5 nipple drinkers under the perches allowed access to one nipple for 10 hens according to the EU-Council Directive (1999/74/EC). Food and water were provided *ad libitum*. The light regimen in the house was 14 h light: 10 h dark with a light intensity of 4-6 lux and temperatures indoors were kept between 11°C and 28°C.

Procedures

Behavioural observations

Hens of each pen group were directly observed in two 3-h periods, once in the morning (9.00-12.00 h) and the second in the afternoon (13.00-16.00 h). Each group was directly observed for 15 min in each observation period by a person who was sitting outside the pen on a high chair with a good view over the whole pen. Because it was impossible to observe the entire pen at one time, each pen was subdivided into two equal segments (Sanotra *et al.*, 2002) that were observed separately. The birds were accustomed to the presence of the observer for 5 min before initiation of behavioural recording.

Feather pecking

All occurrences (Altmann, 1974) of feather pecking interactions in a group were recorded (5 periods of 3 min). Feather pecks that were successively directed at the same receiver were recorded as one single interaction. An interaction ended when there were no more pecks during a period of 4 s. Interactions were classified as: A-“**Gentle**”: gentle pecks at feathers, not resulting in feathers being pulled out and neither does the receiver show a reaction to the peck. B-“**Severe**”: forceful

114 pecks, sometimes feathers are pulled out and the receiver of the peck may move
115 away. C-“**Aggressive**”: were always severe and fast, directed mainly at the head
116 and given in a downward direction, occasionally when the attacked bird was
117 moving away; an aggressive peck could also be directed to other parts of the
118 body. The body parts to which pecks were directed (head, neck, back, rump, tail,
119 wing, belly, breast and leg) were recorded. All rates of feather pecking are given
120 as number of occurrences.

121 *Other behavioural activities*

122 The recording of feather pecking interactions was briefly interrupted every 3 min
123 for a scan sample of other activities. The number of birds engaged in 8 mutually-
124 exclusive activities were recorded for each scan (feeding, drinking, preening,
125 standing, sitting, foraging, moving and dust bathing). The percentage of birds
126 engaged in each behaviour was calculated during all scan samples for each pen.
127 Behavioural observations were carried out at 8 ages: 6, 10, 15 (rearing period),
128 and 20, 25, 30, 35 and 40 weeks (laying period in PH and WG). In addition, the
129 location (perch, floor, slats and feeding area) of the recipient bird during feather
130 pecking was recorded.

131 *Feather scoring*

132 All birds from each pen were individually scored at 15, 32 and 39 weeks of age.
133 For inspection of feather condition, each bird was taken from the pen and 11
134 individual parts of the body (Gunnarson *et al.*, 1995), "head, neck, under the neck,
135 back, rump, tail, wings (wing-primary feathers and wing coverts), abdomen,
136 breast and legs" were carefully examined for damaged, broken, and missing
137 feathers and bald patches. Each body part was given a score from 0 (best) to 6

(worst), with special criteria used for scoring of flight feathers (the tail and the primaries) compared to the feathers of the rest of the body that were differentiated for the types, number, length and damages (Table 1). The feathers under the neck and breast were excluded because of the interfering effects of feeder edge and brood patch on feather damage. A sum of all given values was taken as a total body score.

(INSERT TABLE 1).

Statistical analysis

Data from behavioural observations, the number of feather pecking in different areas and locations as well as feather scores at different parts of the body were analysed using generalised linear models (T-test: GLM- procedure, SAS Institute, 2001). Behavioural observations data from different ages were combined for the analysis within the rearing and laying period. Residuals were tested for normal distribution before analysis.

The following model was used:

$$Y_{ikl} = G_i + Per_k + residual_{ikl}$$

where

Y = feather pecking or the type of behaviour observed (feeding, drinking, foraging, preening, walking, standing and dust bathing), Feather score

G_i = effect of group (feather treatment)

Per_k = effect of period (k= morning or afternoon)

Residual= residual factors.

RESULTS

There were no differences in the rates of feather pecking, as well as feather pecking forms (gentle, severe and aggressive pecks) between the CT and FR groups in the rearing period, as shown in Table 2. In contrast, birds in the CT groups exhibited a higher rate of feather pecking ($P=0.007$; see Table 3), and a more severe form of this behaviour ($P<0.001$) in the laying period. Hens in the FR group exhibited more gentle FP ($P<0.05$; see Figure 1).

(INSERT TABLES 2 and 3 and FIGURE 1)

Time of day had an effect on the rate of feather pecking, as feather pecking rates within the groups were in general greater in the afternoon compared to the morning periods ($P < 0.001$, CT; < 0.05 , FR). However, the control group exhibited higher rates of afternoon feather pecking compared to the FR group ($P=0.011$; see Table 3).

The distribution of feather pecking to the various body regions are shown in Figures 2a and 2b. Birds in the control group pecked to a greater extent to most of the body parts in both the PH and WG, however, the difference did not reach significance. Wings, rump, tail and back were the main targets for feather pecking.

(INSERT FIGURES 2a, b)

Behavioural activities were similar for both groups except for walking (see Table 4). The percentage of hens walking was greater ($P=0.004$) in birds of the control group.

(INSERT TABLE 4)

Feather condition of the different body regions as well as the sum of total feather score was similar between groups during the rearing period ($P>0.05$). In general there was little plumage deterioration at the end of the rearing period. Results from feather scoring at different ages during the laying period are shown in Table 5.

(INSERT TABLE 5)

Plumage damage increased with age during the laying period. At 32 weeks of the age, feather condition on the back and wing-coverts of the birds in the CT groups were worse than for the FR birds ($p=0.043$, 0.007 , respectively). Accordingly, birds in the FR group had less damaged feathers on the neck, back, wing-coverts and leg ($P=0.019$, 0.044 , 0.029 , 0.001 , respectively) at 39 weeks of the age. In addition, the sum of feather scores for all body parts was better in birds of the FR groups at 32 and 39 weeks of age ($P=0.002$, 0.007 , respectively).

In Figure 3 feather pecking (%) is compared at different locations. Most feather pecking occurred on the floor, followed by the feeding area, slats and perches in both groups.

(INSERT FIGURE 3)

DISCUSSION

The hypothesis that feather eating may be a precursor to subsequent damaging pecks (Savory and Mann, 1997; McKeegan and Savory, 1999) is supported by our results, which suggested that birds may have learnt to peck and to eat loose feathers from the floor that were available during the rearing period, because feather moulting occurs three times during this period (Appleby *et al.*, 1992).

207 When there is a shortage of loose feathers during the laying period, attention may
208 have been redirected towards the feathers of conspecifics and hence developed
209 into feather pecking. This is indicated by an increase in both total rate and severity
210 of feather pecking in the control group. Although highly significant, these
211 treatment differences were relatively small. Nevertheless, this result tends to be
212 consistent with McKeegan and Savory (1999), who reported that short feathers
213 were eaten preferentially and long feathers were partially eaten by pullets when
214 short feathers were no longer available from the litter; once feather eating has
215 become established, a low availability of suitable-sized feathers may cause feather
216 eating and pecking to be redirected towards other birds. Also, Forkman (2003)
217 found that birds that had previously loose feathers on the floor (during the rearing
218 period) displayed a more severe feather pecks at 20 weeks of age than those
219 deprived of loose feathers. Unfortunately his experiment was terminated after
220 three days of observations due to ethical reasons.

221 Feather pecking was observed with a higher frequency in the afternoon, in
222 accordance with a study of Preston (1987) who found feather pecking in general
223 to occur mostly in the afternoon. Birds showed increased activities in the
224 afternoon with more foraging, dust bathing, movement and feeding (Vestergaard,
225 1982; Appleby *et al.*, 1992; Channing *et al.*, 2001), which might be accompanied
226 by more feather pecking. This supports our results which showed that increased
227 walking activity was accompanied with a higher rate of feather pecking in the
228 control groups. Also, our results are in agreement with Newberry *et al.* (1988) and
229 Riber *et al.* (2007) who reported that an increase in general activity leads to
230 increases in feather pecking behaviour. Klein *et al.* (2000) reported that increased

231 moving is a sign of frustration. It can be interpreted as an attempt to increase the
232 chances of finding the stimuli which the birds need. Mahboub *et al.* (2002, 2004)
233 found that walking and the frequency of short outdoor visits in free range laying
234 hens was associated with a high probability of occurrence for being pecked.

235 Hens located on the floor were reported to receive more feather pecks than
236 hens on the perches (Wechsler and Huber-Eicher, 1998). This supports our results
237 that the majority of feather pecks occurred on the floor during the laying period.
238 This may be attributed to many behaviours performed on the floor such as sitting
239 or standing on the floor, and dust bathing behaviour which were found to be
240 associated with a high frequency of feather pecking (Vestergaard, 1994; Huber-
241 Eicher and Wechsler, 1998). In addition, Bilčík and Keeling (2000) reported
242 increasing frequency of aggressive pecks with increasing group size.

243 Most feather pecks in the current study were directed to the wings, rump,
244 tail and back, in agreement with findings from other studies (for example,
245 Wechsler *et al.*, 1998). Savory and Mann (1999) reported that feather loss
246 typically commenced at the base of the back where litter particles tend to be
247 attached and where there are relatively short feathers, which may be both easily
248 plucked and preferred for eating.

249 Feather scoring is often used as a convenient measure to assess feather
250 pecking in flocks of laying hens (Hughes and Duncan, 1972; Gunnarsson *et al.*,
251 1999). Our results demonstrated that there was little plumage deterioration at the
252 end of the rearing period. This may be attributed to a low rate of the severe form
253 of feather pecking observed in the current study during the rearing period which
254 usually causes most of the feather damage. Proctor and Lynch (1993) reported

that relatively minimal feather pecking combined with a rapid series of moults during the first months of life may explain why pullets reared commercially often appear to be fully feathered, however, feather pecking does take place during the rearing period. Plumage deterioration increased with age during the laying period. A rise in the rate of feather pecking has been found to correspond with the rise in gonadal hormones inducing egg laying (Hughes, 1982). Rodenburg and Koene (2003) also reported that the intensity and severity of feather pecking seems to depend on age. Gentle feather pecking is mostly observed in young chickens (Kjaer and Sørensen, 1997; Wechsler *et al.* 1998) and severe feather pecking is more often seen at a later age (Huber-Eicher and Sebö, 2001*b*). This may explain the rapid changes in plumage condition of different body parts that were recorded during the laying period. Hens in the control groups were rated with a worse feather score than hens in the FR groups. This may be attributed to the difference in the amount and severity of feather pecking behaviour among groups, which was reflected in the plumage condition. Because birds in the control groups have learnt to peck and eat feathers from the floor, and due to a lack of feathers from the floor during the laying period, they have pecked, pulled out and eaten feathers from pen mates. Therefore, feather pecking rates as well as the severe form of this behaviour were highest in the control groups leading to a deterioration of feathers. This is in agreement with Huber-Eicher and Sebö (2001*a,b*) who found that individuals characterised by relatively high rates of feather pecking performed more frequently the severe form of this behaviour. Also, Huber-Eicher and Sebö (2001*a*) reported that feather scoring actually measures indirectly the amount of

278 severe feather pecks, but because of the proportionality it also indicates the total
279 amount of feather pecking.

280 The suggestion that feather damage is caused by severe feather pecks is
281 supported by the results from Vestergaard *et al.* (1993) and Bilčík and Keeling
282 (1999) who demonstrated that severe feather pecks and not gentle feather pecks or
283 aggressive pecks caused most of the feather damage on the body of the laying
284 hens. Moreover, McAdie and Keeling (2000) found that damaged or broken
285 feathers or even denuded areas due to feather loss may stimulate more feather
286 pecking.

287 In conclusion, our results suggest that the presence of loose feathers on the
288 floor may play an important role in the development and severity of feather
289 pecking behaviour in laying hens, and support the hypothesis that feather pecking
290 can be viewed as redirected foraging behaviour. However, these results need to be
291 verified on the basis of larger sample and group sizes.

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TABLE 1. *Description of the scoring method used to evaluate feather condition (modified from previous methods, BILČÍK and KEELING 1999). A different scale was used for flight feathers (wing primaries and tail) compared to feather condition of the rest of the body*

Scores	Body feather	Flight feather
0	Intact feathers.	Intact feathers.
1	Some feathers scruffy and/or up to 5 damaged feathers.	Few separated feathers up to 5, but none damaged, broken or missing.
2	> 5 damaged feathers and/or up to 5 broken feathers.	> 5 feathers separated and/or up to 5 damaged feathers.
3	> 5 broken feathers and/or up to 5 missing feathers.	All feathers separated, or > 5 feathers damaged or up to 3 broken.
4	Bald patch < 50 % of area.	All feathers damaged and/or > 3 feathers broken or up to 3 feathers missing.
5	Bald patch > 50 % of area.	All feathers broken or > 3 feathers missing.
6	Completely denuded area.	Almost all feathers missing.

TABLE 2. *Least squares means ($\pm$ standard error) and P-value for feather pecking (FP) rate and feather pecking forms during the rearing period*

Items	Control	Feather Removal	P-value
Total FP (n)	9.77 ($\pm$ 1.13)	8.53 ($\pm$ 0.76)	NS
Gentle FP	6.50 ($\pm$ 1.07)	5.70 ($\pm$ 0.72)	NS
Severe FP	2.63 ($\pm$ 0.39)	2.27 ($\pm$ 0.32)	NS
Aggressive FP	0.63 ($\pm$ 0.11)	0.57 ($\pm$ 2.11)	NS

TABLE 3. Least squares means ($\pm$ standard error) and *P*-value for feather pecking rate and effect of day time (laying period)

Items	Control	Feather removal	<i>I</i> -value
Total feather pecking	12.60 ^a ($\pm$ 0.53)	11.01 ^b ($\pm$ 0.40)	0.007
Time of day			
am	11.22 ($\pm$ 0.56)	10.16 ($\pm$ 0.44)	NS
pm	13.98*** ($\pm$ 0.86)	11.86* ($\pm$ 0.65)	0.011

Statistically significant at **P* < 0.05, *** *P* < 0.001 (within the group).

TABLE 4. *Least squares means ($\pm$ standard error) and P-value for total number of hens (%) observed performing various behaviours*

Behaviour	Control	Feather removal	P-value
Feeding	10.84 ($\pm$ 1.18)	11.87 ($\pm$ 1.35)	NS
Drinking	8.11 ($\pm$ 0.92)	7.99 ($\pm$ 0.89)	NS
Foraging	30.93 ($\pm$ 1.89)	32.86 ($\pm$ 1.83)	NS
Preening	16.50 ($\pm$ 1.09)	14.07 ($\pm$ 0.88)	NS
Walking	8.39 ^a ($\pm$ 0.39)	6.13 ^b ($\pm$ 0.50)	0.004
Standing	10.71 ($\pm$ 1.00)	10.47 ($\pm$ 0.78)	NS
Sitting	7.51 ($\pm$ 0.56)	7.69 ($\pm$ 0.72)	NS
Dustbathing	3.94 ($\pm$ 0.90)	5.93 ($\pm$ 0.98)	NS

428 **TABLE 5.** *Least squares means ($\pm$ standard error) and P-value for feather scoring at 32 and 39 weeks of age*

Items	Control	Feather removal	P-value	Control	Feather removal	P-value
Body parts	32 weeks			39 weeks		
Head	1.84 ($\pm$ 0.08)	1.76 ($\pm$ 0.06)	NS	2.71 ($\pm$ 0.10)	2.68 ($\pm$ 0.12)	NS
Neck	2.50 ($\pm$ 0.07)	2.41 ($\pm$ 0.07)	NS	3.84 ^a ($\pm$ 0.06)	3.62 ^b ($\pm$ 0.08)	0.019
Back	1.88 ^a ($\pm$ 0.05)	1.73 ^b ($\pm$ 0.07)	0.043	3.04 ^a ($\pm$ 0.11)	2.74 ^b ($\pm$ 0.10)	0.044
Rump	1.74 ($\pm$ 0.09)	1.53 ($\pm$ 0.07)	NS	2.51 ($\pm$ 0.08)	2.66 ($\pm$ 0.09)	NS
Tail	2.54 ($\pm$ 0.07)	2.41 ($\pm$ 0.09)	NS	2.71 ($\pm$ 0.09)	2.55 ($\pm$ 0.08)	NS
Wing-coverts	2.02 ^a ($\pm$ 0.05)	1.73 ^b ($\pm$ 0.09)	0.007	2.96 ^a ($\pm$ 0.06)	2.72 ^b ($\pm$ 0.07)	0.029
Wing primaries	3.18 ($\pm$ 0.07)	3.10 ($\pm$ 0.07)	NS	3.38 ($\pm$ 0.05)	3.68 ($\pm$ 0.08)	NS
Belly	1.26 ($\pm$ 0.07)	1.12 ($\pm$ 0.04)	NS	2.45 ($\pm$ 0.08)	2.36 ($\pm$ 0.08)	NS
Leg	2.22 ($\pm$ 0.06)	2.22 ($\pm$ 0.06)	NS	3.78 ^a ($\pm$ 0.06)	3.40 ^b ($\pm$ 0.10)	0.001
Total body parts	19.18 ^a ($\pm$ 0.24)	18.02 ^b ($\pm$ 0.28)	0.002	27.84 ^a ($\pm$ 0.34)	26.43 ^b ($\pm$ 0.45)	0.007

FIGURE 1. Least squares means ($\pm$ standard error) for feather pecking forms during the laying period (*** $P < 0.001$, * $P < 0.05$).

a. Poultry house

b. Winter garden

FIGURE 2. Least squares means ($\pm$ standard error) for the feather pecking directed to various body parts in the Poultry house (a) and Winter garden (b).

FIGURE 3. *Feather pecking locations of occurrence.*