MEASURING PECKING OF A BUNCH OF FEATHERS IN INDIVIDUALLY HOUSED HENS: FIRST RESULTS OF GENETIC STUDIES AND FEEDING RELATED REACTIONS

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Introduction

Studies on the genetic basis of feather pecking have shown that there is sufficient genetic variation within layer strains which theoretically can be used for genetic selection (Bessei, 1984a,b; 1985, 1995; Keeling and Wilhelmson, 1995; Kjaer, 1995a; Craig and Muir,1993). The application of behavioural traits in practical poultry breeding, however, is hampered by problems of recording and standardising the selection traits (Faure, 1981; Bessei, 1985). This holds also true for feather pecking. Since this behaviour usually occurs in short bouts, which are not very frequent and unpredictable in time, it is extremely time consuming to collect reliable data, especially when large numbers of birds have to be observed. Therefore attempts have been made to measure feather pecking automatically and under standardised conditions.

The first attempt of automatic measuring of the feather pecking activity in individually caged laying hens has been reported by Bessei (1984a). The methodology was based on observations of Cuthbertson (1980) and own unpublished experience, that chicken show high interest in, and pecked at, feathers which are presented to them by an observer. The pattern of pecking and the posture of the birds while pecking was similar to those of pecking of the feathers of their pen mates. In the following the development of the technique and results from various experiments will be reported.

Measuring pecking of a bunch of feathers as an all-or-none trait

The first experiments have been carried out by a simple computer-supported measuring device. The keels of a bunch of feathers were fitted in a metal tube and fixed on a thin piece of resilient steel so that pecking at and pulling of the feathers produced oscillation. This oscillation was recorded by a microphone and transferred into all-or-none counts. Differentiation between vigorous feather pulling (VFP) and gentle feather pecking (GFP) was not possible.

Heritability estimates of the visually recorded feather pecking during rearing and the automatically recorded pecking in the individually housed layers were of similar magnitude (.20 and .18), but both, the genetic and phenotypic correlation between the different traits was almost zero (table 1).

Table 1: Heritabilities and genetic correlation of visually observed feather pecking (FPvis), being pecked (BPvis) and automatically recorded pecking towards a bunch of feathers (FPaut) in a tinted layer strain (Bessei, 1984b)

Traits	FPvis	BPvis	FPaut
FPvis	.20	.08	-.04
BPvis		.25	-
FPaut			.18

One of the potential causes for the lacking correlation may be the fact that there was no differentiation between different types of feather pecking behaviour. Kjaer (1995b) observed GFP and VFP separately in floor reared hens and found that only VFP increased with higher light intensity whereas GFP prevailed under dim light conditions. It was concluded that GFP and VFP are distinct types of behaviour. Consequently the device for automatic recording of feather pecking has been modified in 1996 using advanced hard and software so as to differentiate between VFP and GFP.

A thinner and therefore more “sensitive” resilient holder of the feather bunch was used, and the oscillations resulting from pulling or pecking were recorded by strain gauges. Special software (Visual Designer) was used which allowed to distinguish between pecking and pulling activities as distinct types of behaviour. This equipment was used in an experiment with a total of 420 pedigreed chickens of a Rhode Island layer strain. The chicks were selected from families which had shown extremely high or low pecking rates as recorded in a previous experiment. They were received at day-old and assigned to 21 groups of 20 individuals each, 11 groups of the low pecking and 10 groups of the high pecking line. The groups were kept in deep litter pens from 1 day-old to 26 weeks of age. Behavioural observations were made visually from 21 to 26 weeks of age. Thereafter the hens were transferred into individual cages, and GFP and VFP were recorded by the above mentioned device separately. The mean values of the high and low pecking lines (HPL and LPL) were significantly different for visually observed VFP and both, GFP and VFP of the bunch of feathers. The means for visually observed GFP did not differ significantly among lines (table 2).

The Spearman rank correlation coefficients for all traits are shown in table 3. The correlation between visually and automatically recorded pecking activities was generally lower within the low pecking line. Visually observed and automatically recorded VFP was highly correlated (r= .82) in the high pecking line. The correlation coefficients between GFP and VFP were generally of positive direction.

Table 2: Mean frequencies of visually observed gentle and vigorous feather pecking (GFPvis;VFPvis), automatically recorded gentle and vigorous feather pecking (GFPaut;VFPaut) of a bunch of feathers in two lines selected for high and low feather pecking (HPL, LPL) in a previous experiment

Lines	GFPvis	VFPvis	GFPaut	VFPaut
HPL	.335	1.124	4.065	6.816
LPL	.326	.876	2.138	3.924
Significance	n.s.	*	*	*

Table 3: Phenotypic correlation (Spearman's rho) of visually observed gentle and vigorous feather peckung (VFPvis, VFPvis), automatically recorded gentle and vigorous feather pecking (GFPaut, VFPaut) of a bunch of feathers in high and low feather pecking lines; values for the high and low pecking lines (HPL, LPL) in the upper and lower part of the table respectively (after Bessei, 1995)

Traits	GFPvis	VFPvis	GFPaut	VFPaut
GFPvis	-	.58	.29	.29
VFPvis	.83*	-	.61*	.30
GFPaut	.33	.54	-	.63
VFPaut	.67*	.82***	.82***	-

* = P< 0,05; *** = p< 0,001

The effect of pelleted feed versus mash

The response of laying hens of the high and low feather pecking line to pelleted feed was tested in a later experiment. Twenty 41 weeks-old hens of each line were housed individually in cages. Each hen was tested on both, a pelleted and mash layer diet which were identical in their nutrient composition. A two-days adaptation phase was provided for each type of feed. Half of the hens were fed with pellets first, the other half started with mash. The feeders were fitted on electronic scales and pecking of the feed (feeding activity, FA) as well as the feed consumption were recorded continuously for 24 hours. Pecking at feather bunches, which had been positioned nearby the feeder, was recorded simultaneously. There was a tendency of increasing feed intake when the hens received pellets. The feeding activity, however, was obviously reduced. The difference of means was closed to the level of significance (table 4). With regard to the feather pecking activity there was a significant increase in VFP when birds of the high pecking line (HPL) received pellets, but there was no such effect in the low pecking line (LPL). Type of feed did not have significant effects on GFP in either lines. The lines differed significantly in both, GFP and VFP.

Table 4: Feed intake, feeding activity (FA), and pecking of a feather bunch (VFP, GFP) of high (HPL) and low (LPL) feather pecking line in response to pelleted feed and mash (after Zeeb, 1998)

Linie	Feed type	Feed intake (g/day)	FA (hours/day)	VFP (n/day)	GFP (n/day)
HPL	Mash	97	3.95	149 a	499
	Pellets	112	2.46	397 b	443
LPL	Mash	104	4.14	52 a	132
	Pellets	108	2.14	42 a	63
Group means					
HPL		105	3.21	273 x	471 x
LPL		106	3.14	473 y	98 y
	Mash	101	4.05	101 A	316 A
	Pellets	110	2.29	220 A	253 A
Overall Means		105	3.17	160	284

means with the same letter do not differ significantly P ≤ 0,05

Feeding pellets to laying hens and turkeys has proved to stimulate feather pecking and cannibalism (Jensen et al., 1963). The increase of feather pecking in response to pellet feeding was thought to be the result of a compensatory effect to the reduced feed pecking activity.The mean values of feeding activity and feather pecking seem to support this hypothesis. The circadian rhythms of feed related pecking and feather pecking of the HPL showed the same results. In the pellets fed HPL there was only a small peak of FA in the morning while both, VFP and GFP activities were high at that time. When mash was fed, there were high peaks in FA in the morning and the evening. VFP remained at a low level throughout the day while GFP showed a high peak in the morning.

The circadian pattern of FA in the LPL was similar on both feed types. The level of VFP and GFP in this line was very low and now clear circadian rhythm was developed.

The inverse relationship between feed intake and feed-related pecking indicates that feed intake per time unit was higher in the pellet fed birds in the morning. It can be assumed that the birds were satiated within short time, either by the filling of the crop or by activation of physiological satiation mechanisms in the hypothalamus. The motivation for pecking may persist under these conditions and pecking activity may be redirected to the feathers of group mates or to the feather bunches. Redirection of feed pecking to feather pecking has been reported by various authors. Huber-Eicher and Wechsler (1997) could demonstrate that deep litter (straw) distracted the pecking activity from the feathers to the litter. Similarily Blokhuis and van der Haar (1992) found that pecking activity of the litter reduced pecking of the feathers.

The hypotheses of feather pecking as redirected feed pecking does not apply in the comparison of the HPL and LPL lines, which differed in their feather pecking activities but not in their feed pecking activity. HPL hens did not respond to pelleted feed by increased GFP as did the LPL hens.

Response to high fibre and high sand diets

Bulky feed requires more feed pecking activity and may reduce feather pecking in concurrence with the compensation theory. In two experiments the pecking towards the feather bunches was recorded in LPL and HPL hens fed isocaloric and isonitrogenic diets containing different levels of fibre or ash through the inclusion of 10 % of oat shells or sand respectively (table 5). Both treatments increased the feed intake as compared to the control feed (tables 6 and 7). Both, VFP and GFP were increased in response to the inclusion of sand but level of significance was reached in the HPL hens only. The energy requirement of the individual hens as calculated on the basis of body weight, egg output and body weight gain (Emmans et al. (1975) showed that there was an overconsumption of 18.7 and 27.8 % resp. in the sand treatment of the HPL and LPL. The inclusion of oat shells produced similar but not significant effects in feed intake and overconsumption of energy. The energy intake in the control group was lower than estimated. There was also a considerable increase in feather pecking activity of the HPL birds which received the oat shell diet, but the differences were not significant in this case.

Figure 1: Ciradian rhythms of feeding activity (FA) in seconds per hour, VFP and GFP of HPL and LPL hens in response to mash and pelleted feed (after Zeeb, 1998)

Table 5: Nutrient composition of the experimental diets; the figures in brackets represent the results of chemical analysis (after Bley, 1998)

	Control	Sand	Oat shells
CP	15.8 (15.8)	15.8 (16.5)	15.8 (16.1)
ME	10.2 (10.1)	10.2 (10.4)	10.2 (10.1)
CF	7.8 (5.6)	7.3 (4.3)	7.3 (10.9)
Ash	12.6 (13.9)	12.6* (23.2)	12.4 (14.7)
Fat	3.9 (4.1)	11.1 (11.0)	11.1 (11.5)

* without sand

Table 6: Feed intake and pecking at a feather dummy of laying hens of a high (HPL) and low (LPL) feather pecking line in response to the inclusion of the 10 % oat shells

	Feed intake (g/day)	Vigorous pulling (n/day)	Gentle pecking (n/day)	Energy intake in % of estimated requi.
HPL Oat shells	133	247 a	128 a	+ 8.6
Control	129	179 a	78 a	- 8.0
LPL Oat shells	154	38 a	11 a	+ 20.0
Control	131	62 a	29 a	- 9.7
Group means				
Oat shell	142	152 A	75 A	
Control	130	125 A	56 A	
HPL	131	213 x	103 x	
LPL	142	50 y	20 y	
Overall Means	136	139	65	

Table 7: Feed intake and pecking at a feather dummy of laying hens of a high (HPL) and low (LPL) feather pecking line in response to the inclusion of the 10 % sand

	Feed intake (g/day)	Vigorous pulling (n/day)	Gentle pecking (n/day)	Energy intake in % of estimated requi.
HPL Sand	149	203 a	135 a	+ 18.7
Control	131	74 b	24 b	+ 5.4
LPL Sand	162	55 b	20 b	+ 27.8
Control	136	48 b	10 b	+ 0.8
Group means				
Sand	155	136 A	83 A	
Control	133	67 B	17 B	
HPL	140	138 x	79 x	
LPL	149	56 x	15 y	
Overall Means	144	101	50	

If we assume that higher feed intake increases the need for feed pecking, and that bulky feed such as finely ground oat shells further increase the feed related pecking activity, it may be expected according to the above mentioned compensation theory, that feather pecking is reduced under such feeding conditions. The present results show that bulky feed - in contrast to the expectation - increased the tendency of pecking towards the feathers.

It has been demonstrated in various experiments that the inclusion of oats which contains high amounts of fibre reduces the incidence of mortality through cannibalism (Seemann, 1982) and /or improves the quality of the feather cover of the hens (Bearse et al., 1940; Scott et al., 1954; Torhaug, 1973; Wahlström et al., 1998). Genotype-feeding interactions have been reported by Seemann (1982) and Wahlström et al. (1998) for feather cover deterioration. Some lines did not respond to changes in the diet while others reacted. In this context it is also interesting to note that the beneficial effect of oats on mortality caused by cannibalism was more pronounced under sub-optimal conditions: The effect of a sodium deficiency (Wahlström et al., 1998) and restricted feeder space (Seemann, 1982) on cannibalism was less pronounced when the diet contained high levels of oats. The effect of high fibre diets on feed and energy consumption is not consistent throughout the different experiments. When high fibre is used to dilute the diet and to reduce ME there is generally an increase of feed consumption, but no full compensation of energy intake is achieved in growing birds and layers (Leeson et al., 1996; Kondra et al., 1976). Other authors reported no negative effects of high fibre diets (Deaton and Kubena, 1977; Moran et al., 1977). Voreck and Kirchgessner (1981) suggested 10 % of fibre as not compromising in layers. In the present experiment isocaloric high fibre as well as high sand rations increased feed consumption and produced an overconsumption of energy. This may partly be attributed to the fact that the high fibre and high sand diets contained large amounts of fat. Overconsumption of feed and energy have not been reported to produce feather pecking and cannibalism so far. It is assumed that the inclusion of sand and oat shells have impaired the digestibility of protein and feather pecking may have been caused by a mild deficiency of amino acids.

HPL hens were generally lighter (about 100-150 g) than the LPL birds. The interrelationships between body weight and feather pecking are not consistent throughout the results which have been reported in the literature. Positive genetic correlation coefficients indicating a higher pecking activity in heavier birds have been found by Bessei (1984b) in pullets. Kjaer and Soerensen (1997) reported negative genetic correlations of body weight and performing feather pecking in 51 weeks old layers. The authors suggested selection for smaller body size may increase the risk for feather pecking, which is in line with the present findings.

Conclusions

The experiments have shown that measuring pecking activity of a feather dummy is a useful tool to identify the tendency of feather pecking of individually caged hens. It may be used to reduce the incidence of feather pecking and cannibalism in layer breeding programs, and to elucidate the reaction of hens to specific experimental conditions, such as feed structure and composition of the diets. With regard to the impredictability of feather pecking in commercial hybrids it is recommended to produce laboratory lines with high and low tendency for feather pecking for particular experiments.

First experiments using HPL and LPL hens as selected by the frequency of pecking of a feather bunch showed that HPL hens increased VFP when fed a pelleted diet. This was expected from earlier experience comparing feather pecking in response to pelleted feed in cages and in deep litter systems. These results confirm the earlier assumption that feather pecking may be a compensatory reaction for a reduced need of feed pecking on the pelleted diet. Studies on the circadian rhythm of feed pecking and feather pecking in the HFP line showed similar results while no such compensation could be found in the LPL. The inclusion of 10% of oat shells or sand to an isocaloric and isonitrogenic diet produced a considerable increase in feed consumption and overconsumption of energy. Although feed pecking activity was not recorded in this experiment it was obvious that higher feed intake and the bulkiness of the oat shell diet increased necessarily the feed pecking activity in comparison with the control diet. Nevertheless the feather pecking activity of the HPL birds was increased considerably in the oat shell and sand rich diets. This result is in contrast with the expected compensation mechanisms which has been assumed in the previous experiments with a pelleted diet. The increase in feather pecking in this case may be explained by a mild deficiency of amino acids of the unconventional diets.

The fact that the HPL and LPL hens reacted in a different way to feed structure, sand and fibre, is consistent with the genotype-feed interactions which have been found in other experiments. It seems that the HPL hens react more sensitively to unconventional structure and composition of the feed than LPL hens.

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