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The behavior of broiler breeders under controlled feeding conditions in response to coarse Ca particles scattered in the litter

Abstract

A total of 23 652 broiler breeders were kept in two identical windowless deep litter pens. The birds were 25 weeks of age at the beginning of the experiment. A conventional breeder mash was supplied under a controlled feeding regime with 120 g/bird and day at the beginning and 170 g at the end of observation. The lighting period was from 2:30h to 17:00h. Feed was delivered in one meal at 6h. In one of the pens 2 g/bird/day of coarse Ca particles were distributed in the litter. Four video cameras were installed in each pen on different positions. The number of birds in a pre-determined area which performed feeding, drinking, walking, preening, litter

pecking and scratching, feather pecking and stereotyped pecking was recorded by instantaneous scan sampling in 10 minutes intervals. Observations were carried out from 4h to 8h (2 hours before and 3 hours after feeding) and one hour in the afternoon (15h). In addition a behavioral profile was made of one camera position over the entire light period. Locomotor activity increased before the supply of feed started. Feeding behavior reached a maximum immediately after the start of the chain feeder operation and declined thereafter over a period of 4 to 5 hours. Litter pecking and scratching increased as pecking in the feeder decreased. Litter pecking was stimulated by spilled mash.

Scattering Ca particles in the litter further increased the level of litter pecking and scratching. There was a low incidence of stereotyped pecking and feather pecking. Redirection of feed pecking towards the litter is considered a useful tool to reduce the development of abnormal behaviours of broiler breeders under controlled feeding regimes.

Introduction

There exist a general antagonism between growth rate and reproduction in domestic animals. Breeds selected for high growth rate allocate nutrients preferably in body mass development. This has detrimental effects egg production, fertility and livabi-

lity. Therefore it is necessary to control the development of body weight development of broiler breeders through reduced feed intake. The common practice is a single meal allocation in the morning using a balanced diet. The control of feed intake below the level of *ad libitum* feeding has been reported to cause welfare problems. It was assumed that the birds would suffer from "chronic hunger" or deprivation of satiation" (Pledl, 2008). Since there exist no valid physiological criteria for hunger as a subjective experience in chickens the most important indicators of suffering are abnormal behaviours. There are many publications showing changes in feeding behavior, locomotor activity, preening, feather pecking and increase of stereotyped behaviors when the feed allocation was regulated below the level the birds would eat under *ad libitum* conditions. It has been assumed that stereotyped behavior is the result of reduced time spent feeding under controlled feeding conditions. The physiological satiation mechanisms may become active in a later phase only (see for review Bessei, 2014). After completion of the daily ration the motivation of feed pecking persists and may be deviated towards non-feed objects, such as feeder, drinker, walls or feathers of pen mates. Eventually this pecking activity appears as stereotyped behavior.

Stereotyped behavior is assumed as indicator of an inadequate feeding behavior. Although there is no consistent interrelationship between stereotyped behavior and hunger throughout the experimental work reported in the literature (Bessei, 2014), the development of this abnormal behavior should be avoided. There are reports showing that feed pecking after completion of the meal can be diverted towards the litter. Litter pecking and litter scratching are considered to express

foraging behavior, which is the adequate response to the bird's situation. Indeed the distribution of whole grains in the litter has been used in layers to stimulate litter pecking and reduce feather pecking in laying hens. The present study was carried out to use coarse Ca particles to direct the pecking activity towards the litter. In order to be effective the distribution of the particles in the litter should be carried out before the feed provided in the feeders is completely eaten.

Materials and methods

A total of 11,556 broiler parent stocks were used, 10,700 females and 856 males. The birds were housed in two windowless houses of 812 m² (80,4 x 10, 1 m) each. Stocking density was 8 birds/m² usable space. Approximately two thirds of the pens were littered with wood shavings and one third was covered with wooden slats. The littered area was located at both side walls. Nests were situated in the central part of the slatted area. Feed was supplied through 3 chain feeder lines, which were located in the deep litter area. Feeder space was 17.6 cm per hen. The males were fed separately on suspended round feeders, one feeder for 8 males each. Feed was provided in a single meal per day at 5:00h. Water was supplied through nipple drinkers, 7.8 birds per nipple. The drinker lines were positioned in front of the nest entrances on the slatted area. Fresh air was supplied through an underpressure ventilation system with a capacity of 8 m³ per kg live weight. Light duration was 14.5 hours, from 2:30h to 17:00h. There was the dim and dusk phase of 15 minutes at the beginning and the end of the light period. A conventional parent stock diet was fed throughout the experiment. The daily feed allocation was 120 g per bird and increased up to 170 g at the end of the observation period. 2 g/bird and day of a coarse

calcium carbonate was scattered in the litter areas. This treatment was carried out by hand about 1 to 1.5 hours after feeding.

Behavioural observations

Two video cameras were installed in each pen, one at the entrance and one in the middle. The viewing range comprised the whole width of the pen including the litter area with the feeders and the slatted area with the drinkers. The area for the behavioural observations was defined by a frame over the video screen, which contained the width (4,35 m) of the pens and a depth of about two meters. Because of different positions of the cameras at the different locations, it was not possible to exactly determine the same size of area on each position. Therefore the number of birds in the region of interest was determined in the first step of observation, and the behavioural data were expressed as percentage of the birds in the defined area. The following behaviours were recorded by instant scan sampling with a 10 minutes interval:

feeding (pecking in the feeder), drinking (pecking at the drinker nipples), preening (pulling the beak through own feathers), scratching/litter pecking (scratching and litter pecking usually occur in repeated sequences), walking (locomotor activity including transitions from the litter area to the slatted floor or on the feeders), stereotyped object or spot pecking (repeated and uniform pecking at feeders, drinkers and other objects).

Behavioural recording took place from February to June 2014. At the beginning of the experiment the birds were the 25 weeks old. In the first step of observations, scans of the entire lighting period were made of one camera position from 2h to 17h in 10 minutes intervals. These results were used to determine the time pattern

of the behaviours over the light period and to select regions of interest for the full evaluation of all camera positions. The following periods over the time of day were determined: 4h to 8h and 15h. Three scans per hour were carried out within the selected time. The observation started when the birds were 25 weeks of age and were repeated in four weeks intervals, from March until June 2014.

Data analysis

The number of birds within the observation area was used as a basis of determination of the percentage of birds showing the above defined behaviours. The results were aggregated as mean values per hour and plotted over time of observation. The overall means of the behaviours in response to the treatments (with and without distribution of calcium particles) were calculated. Since only one replicate (pen) per treatment was available, the effect could not be tested statistically.

Results

The overall means of the behaviours in response to the treatments are shown in table 1. There were only minor differences between the treatment and the control.

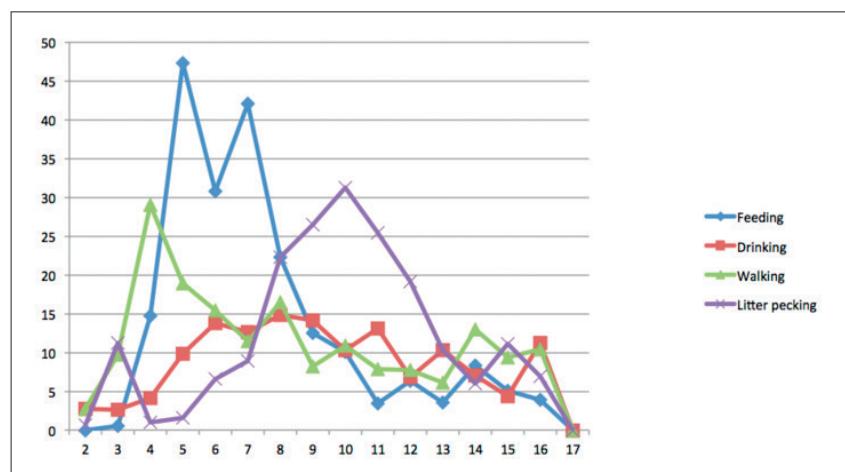


Figure 1: Diurnal pattern of different behaviours (%) of broiler breeders under restricted feeding programme over the light period from 2 to 17H

beginning of the light period and increased only immediately before the feeder chains were operated. In this case the flock moved towards the incoming feed and for a short time (10 minutes) about 70 to 80% of the birds showed intensive walking. The hourly average, however, was about 30% only. As soon as the feed had arrived, the birds formed a line standing at both sides of the feeder chains. Walking activity remained relatively high in the first phase of feeding as there was a frequent change of place at the feeder. Within two hours after the start of feeding, walking activity de-

creased for three hours after feeding was in between 40 and 50% only. The percentage of birds spent drinking was less than 5% at the onset of the feeding period and increased towards 15% within the first two feeding hours. A relatively high drinking activity was retained thereafter and a decline below 10% in the afternoon. Litter pecking and scratching showed a peak after onset of light (10%) and declined when the birds started feeding. With the reduction of feeding activity litter pecking and scratching increased continuously up to 30% and declined thereafter. Feather pecking and preening represent only small part of the behavioural budget (figure 2). Similar to litter pecking and scratching there was a small peak of preening in the second hour after the light was switched on. Thereafter it declined towards zero and increased again slowly towards the afternoon (12%). Feather pecking was not observed in the morning and showed a level of about 4 to 5% in the afternoon.

Stereotyped pecking at the feeder chain and other objects could be clearly differentiated from food pecking and litter pecking. The frequency of stereotype pecking was too small to be presented in a graphic.

Treatment	Feeding	Drinking	Walking	Preening	Litter pecking / Scratching
Control	20,53	5.631.3	12.191.4	5,47	7,12
Ca particles	22,61	6,08	13,83	4,78	8,05

Table 1: Percent of birds spent feeding, drinking, walking, preening and litter pecking/scratching in response to the distribution of ca particles in the litter and control

There was however a tendency of more feeding, walking and scratching litter pecking and less preening in the group receiving calcium particles.

The temporary profile of the different behaviours over the time of day is shown in figures 1 and 2. Walking was low after the

lined remarkably and there was a further decline towards the end of the light period. At the beginning of the light period the number of birds feeding was low. Pecking in the feeder started immediately after the feed chain was activated. For short intervals the percentage of birds spent feeding was over 90%. The hourly average, how-

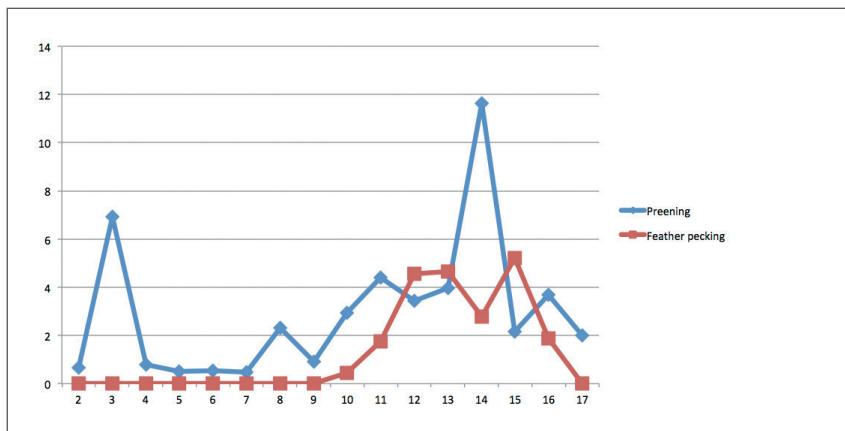


Figure 2: Diurnal pattern of preening and feather pecking (%) of broiler breeders under restricted feeding programme over the light period from 2 to 17H

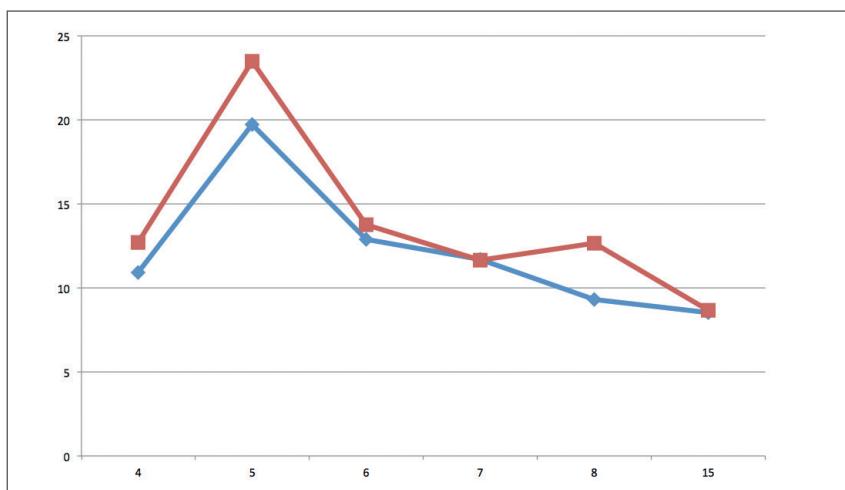


Figure 3: Percentage of birds spent walking in response to time of day. Red line: Ca particles; blue line: control

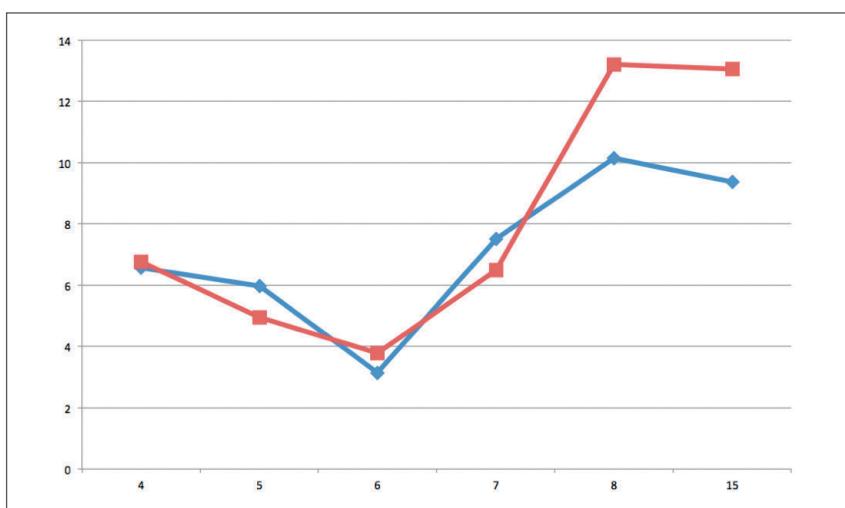


Figure 4: Percentage of birds spent pecking and scratching in the litter. Red line: Ca particles in the litter; blue line: control

Six events have been recorded in the control and nine events in the treatment group over the entire observation period.

The means of walking over the observation time that is shown in figure 3 for the control and the treatment groups. Birds of the treatment groups showed a higher frequency of walking then the control in 4 of 6 observation hours. The means of feeding were similar in both, control and treatment. The treatment groups showed a higher feeding activity in the hour of the distribution of calcium particles only. The means of drinking was also higher in the treatment than in the control groups at the beginning of the light period. But there was no difference between the groups thereafter. With regard to litter pecking and scratching there was only an obvious difference between control and treatment groups at 9 am and 15 pm (figure 4). There was no difference in the means of feather pecking throughout the observation periods.

Discussion

Feeding behaviour in chickens represents a large part of the total behavioural budget. Under ad libitum feeding laying hens spend about 40% of the light period food pecking. The feeding activity under ad libitum feeding follows a biphasic pattern with one maximum in the morning and another in the afternoon. When feed is supplied below the ad libitum level, the pattern of feeding behaviour is determined by the time of feeding and the level of feed restriction. The intensity of feed intake increases with the severity of feed restriction, and feeding activity is concentrated on the time of feed supply. The total time spent feeding is reduced concurrently with the level of feed restriction. The intensity of feed intake after feed deprivation or under different levels of feed restriction has been used as an

indicator for the strength of feeding motivation or hunger in chickens (Wood-Gush and Gower, 1968). The reduction of time spent feeding is considered the cause of stereotyped pecking activity. The birds in the present study, however, showed little pecking in the feeder, in the litter or stereotyped pecking during the first hours of the light period, though hunger is supposed to be greatest at that time. This is in agreement with findings of Puterflam et al. (2006). In contrast to our expectation the birds were very quiet and approached the feeder only a short time before the feeder chain was operated. The increase in walking and pecking in the feeder prior to feeding was probably initiated by acoustic and visual stimuli related to the preparation of feeding, e.g. opening of doors and appearance of the stock personnel. Very high feeding activities (90%) occurred for a short period only after the arrival of feed. The hourly averages were 40% to 35% in the two hours following feeding. These values are lower than those reported by Puterflam et al. (2006) in feed restricted broiler parent stocks (54.5%) but similar to the ad libitum fed birds of the same authors (42.5%). This shows that supply of fresh feed also stimulates the feeding activity in ad libitum fed birds. The overall daily means of time spent pecking in the feeder varied from 20 to 22%. This is within the range of feeding activity of parent stocks reported by Puterflam et al. (2006) (17.4%) and Hocking et al. (1997) (30%). The percentage of birds pecking in the empty feeder was 6.5% and 3.5 to 13.9% respectively as reported by Puterflam et al. (2006) and Pledl (2008). The differentiation of feed pecking and pecking in the empty feeder is difficult under practical conditions. It is not possible to exactly determine the time when there is no feed left. Feed consumption is getting more difficult when the feed level declines. There remain some

feed particles in between and underneath the elements of the feeder chain which are difficult to acquire. It has also to be considered, that under even under ad libitum feeding a considerable part of pecking activity in the feeder is not connected with feed intake (Bareham, 1972; Masic et al., 1974). Therefore pecking in the empty feeder cannot generally be assumed as abnormal behavior. Therefore the data on feed pecking and pecking in the empty feeder reported in the literature has to be considered with care. There is spillage of feed into the litter, in particular when the feed is presented as mash. In the present study there was increasing litter pecking as pecking in the feeder decreased (figure 1). This suggests a gradual transition from feeding of the trough towards feeding of the litter and litter pecking and scratching as explorative behavior. Similar results have been reported by Savory and Maros (1993) and de Jong et al. (2005).

In the present study the pattern of pecking in the feeder occurred at a low frequency in the time, when there is no feed left in the feeder, e.g. evening and in the morning before feeding. Nevertheless the pattern of this pecking activity did obviously not differ from the normal feed or litter pecking and could clearly be differentiated from stereotyped pecking. The latter, which has been described as abnormal behavior in response to feed restriction, was found very rarely in the present study. This may be due to the fact that feed was provided as mash and the feeders were located in the litter area. There is more feed spillage with mash than with pelleted feed, and the spilled feed redirects the pecking activity towards the litter as soon as the feeder is emptied. Litter pecking, in contrast to stereotyped pecking, is considered a natural expression of foraging behavior. Therefore redirection of the pecking activity from the feed to the litter has

been recommended as a means to reduce stereotyped pecking in chickens (Nicol et al., 2001). In some studies on feed restriction of broiler breeders the authors recorded stereotyped walking (pacing) (Savory and Maros, 1993). Increased walking was observed immediately before the delivery of feed. This behavior showed no stereotypic pattern. In line with our observations, Kostal et al. (1992) reported increased non-stereotypic walking behavior prior to feeding in broiler breeders. There was a tendency of increased walking activity in the group which received Ca particles in the present study. This indicates that the treatment increased foraging behavior in general. Restricted feeding has been reported as risk factor for feather pecking. Feather pecking occurred in the present study at a very low level in the afternoon. The low incidence of this damaging behavior may be attributed to the high level of foraging behavior. Occupation with litter has proved to attenuate feather pecking in many studies (van Krimpen et al., 2009; Kjaer and Bessei, 2013).

The distribution of Ca particles in the litter showed only a short time effect on litter pecking, which is not reflected in the mean values of the hour of application in figure 1. However, there was obviously a long lasting effect and the litter pecking and scratching. This behaviour was clearly higher at 9h am and 15h pm in the treatment group than in the control (figure 4). This shows that it is possible to redirect the pecking activity through strategic feeding. This measure may show more pronounced effects when the birds are fed pelleted diets and the feeders are located on the slatted area where the birds are not able to retrieve spilled feed. Other behaviours were not influenced by the treatment.

Summary and conclusions

Under controlled feeding conditions the diurnal pattern of behavior is determined by the time of feeding. After leaving the roosting places in the morning the birds remained calm and stand nearby the feeders. Locomotor activity increased a short time before feed delivery. The rise in activity was obviously triggered by stimuli related to feeding. Pecking in the feeder started on a high level when the feed was delivered and declined gradually over a period of 4 to 5 hours. Pecking and scratching in the litter increased with decreasing pecking in the feeder, suggesting a compensatory behavior for feed pecking. The high level of pecking and scratching in the litter was obviously caused by the fact that the feeders were placed in the litter area and spilled mash redirected feed pecking towards the litter. Scattering Ca-particles in the litter lead to further increase of litter pecking and locomotor activity. Both behaviours are considered as expression of scavenging behavior. The high level of litter pecking is considered the reason for the low level of stereotyped behavior and feather pecking in the present study. The present study shows that abnormal behavior can be prevented in broiler parent stocks kept under controlled feeding conditions through redirection of pecking behavior towards the litter.

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References

Bareham, J.R. 1972. Effects of cages and semi-intensive deep litter pens on the behaviour, adrenal response and production in two strains of laying hens. *Br. Vet. J.* 128:153.

Bessei, W. 2014. Über den Einfluss der rationierten Fütterung auf das Wohlbefinden von Mastelternieren – Eine Literaturstudie. *Europ. Poult. Sci.* 78:

de Jong, I.C., M. Fillerup, and H.J. Blokhuis. 2005. Effect of scattered feeding and feeding twice a day during rearing on indicators of hunger and frustration in broiler breeders. *Appl. Anim. Behav. Sci.* 92:61-76.

de Jong, I.C., H. Gunnink, J.M. Rommers, and M.B.M. Bracke. 2013. Effect of substrate during early rearing on floor- and feather pecking behaviour in young and adult laying hens. *Arch. Geflügelk.* 77:15-22.

Hocking, P.M., B.O. Hughes, and S. Keer-Keer. 1997. Comparison of food intake, rate of consumption, pecking activity and behaviour in layer broiler breeder males. *Brit. Poult. Sci.* 38:237-240.

Kjaer, J., and W. Bessei. 2013. The interrelationships of nutrition and feather pecking in the domestic fowl - A review. *Arch. Geflügelk.* 77:1-9.

van Krimpen, M.M., R.P. Kwakkel, C.M.C. van der Peet-Schwingen, L.A. den Hartog, and M.W.A. Verstegen. April 2009. Effects of nutrient dilution and nonstarch polysaccharide concentration in rearing and laying diets on eating behavior and feather damage of rearing and laying hens. *Poultry Science* 88:759-773. doi:10.3382/ps.2008-00194

Kostal, L., C.J. Savory, and B.O. Hughes. 1992. Diurnal and individual variation in behaviour of restricted-fed broiler breeders. *Appl. Anim. Behav. Sci.* 32:361-374. doi:10.1016/S0168-1591(05)80028-0.

Masic, B., D.G.M. Wood-Gush, I.J.H. Duncan, C. McCorquodale, and C.J. Savory. 1974. A comparison of the feeding behaviour of young broiler and layer males. *British Poultry Science* 15:499-505.

Nicol, C.J., A.C. Lindberg, A.J. Phillips, S.J. Pope, L.J. Wilkins, and L.E. Green. 2001. Influence of prior exposure to wood shavings on feather pecking, dustbathing and foraging in adult laying hens. *Appl. Anim. Behav. Sci.* 73:141-155.

Puterflam, J., F. Merlet, J.M. Faure, P.M. Hocking, and M. Picard. 2006. Effects of genotype and feed restriction on the time-budgets of broiler breeders at different ages. *Appl. Anim. Behav. Sci.* 98:100-113. doi:10.1016/j.applanim.2005.08.013.

Savory, C.J., and K. Maros. 1993. Influence of degree of food restriction, age and time of day on behaviour of broiler breeder chickens. *Behav. Processes* 29:179-189. doi:10.1016/0376-6357(93)90122-8.

Wood Gush, D.G.M., and D.M. Gower. 1968. Studies on the motivation in feeding behaviour of the domestic cock. *Anim. Behav.* 16:101-107.