Effect of whole wheat and feed pellets distribution in the litter on broilers' activity and performance

Einfluss des Streusens von Weizenkörnern und Futterpellets in die Einstreu auf Aktivität und Wachstum von Broilern

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Introduction

Broilers have been subjected for decades to intensive genetic selection for growth rate and feed conversion. This resulted in significantly shorter fattening period but also in numerous skeletal and cardiovascular diseases (Emmerson, 1997). Leg disorders have been recognized as a major cause of poor animal welfare in commercial broiler production (EU, 2000). Twenty-six to 30% of broilers have leg problems (Sanotra et al., 2003), which are likely painful (Pickup et al., 1997). Those birds whose walking ability is substantially impaired tend to be lighter (Haye and Simons, 1978; Kestin et al., 1999) and may suffer from thirst or hunger due to inability of reaching drinkers and feeders (Butterworth et al., 2002). However, leg disorders do not only present serious welfare problem, but may also cause economical losses. Over 2% of animals die or need to be culled because of leg problems (Grashorn, 1987). Nevertheless, it has been reported that the onset of leg disorders can be reduced or delayed with increased physical activity (Haye and Simons, 1978; Reiter and Bessei, 1998; Reiter, 2004). Mechanical stress on the locomotor system caused by locomotion activates bone formation processes and improves bone quality (Djukić Stojčić and Bessei, 2009; Reiter and Bessei, 1998). Broilers spend about 60% (Bokkers and Koene, 2003; Murphy and Preston, 1988) to 90% (Arnould and Faure, 2003; Reiter, 2004; Weeks et al., 2000) of their time inactive. It was assumed that selection for higher growth rate and for more efficient feed conversion decreased broiler's spontaneous activity (Reiter and Kuttertz, 2001; Weeks et al., 2000). Additionally, selection for rapid growth of breast muscle resulted in change of body conformation, that is moving the centre of body gravity forward (Corr et al., 2003a). This unbalances the birds and causes standing and moving to be energy consuming and tiring (Corr et al., 2003b). Furthermore, it seems that walking is painful even for birds with rather good walking ability (McGown et al., 1999). For these reasons it is very difficult to stimulate physical activity in broilers. Attempts to achieve this with increment of environmental complexity by offering strings, sand trays (Arnould et al., 2004; Leterrier et al., 2001), barriers between drinkers and feeders (Bizeray et al., 2002a), toys and ramps (Balog et al., 1997; Bessei, 1992a), were not very successful. However, locomotor activity was enhanced by offering broilers bales of straw (Kells et al., 2001), by increasing the distance between feeders and drinkers (Reiter and Bessei, 1996), sequential feeding (Bizeray et al., 2002c), modification of light programs (Sanotra et al., 2002; Schwean-Lardner et al., 2006; Schwean, 2002), and high light intensity (Hester, 1994; Newberry et al., 1986; Olarewaju et al., 2006).

One of the possibilities to enhance locomotor activity in chickens is the stimulation of foraging behaviour. Scattering whole grain in the litter has been used traditionally in deep litter systems for laying hens. It is known as useful means to elicit foraging behaviour, and thus, to increase scratching and locomotor activity (Appleby et al., 2004). The aim of our study was to apply this procedure in broilers. We tried to achieve this by a) scattering whole wheat grains in the litter in addition to standard feed offered ad libitum in a trough and b) removal of feed trough and scattering standard pellets in the litter.

Material and methods

Animals and housing

The study included 120 Ross 308 one-day-old broiler chickens of mixed sex. The animals were randomly allotted to 12 small wooden pens (dimension 77 × 77 cm) of 10 birds each. At housing, live body weight of a group of 10 birds allotted to the same pen was used as criterion, such that the difference in weight among pens was minimized. Four pens were allotted to the control treatment (C), four to the W treatment where whole wheat was scattered in the litter, and four to the P treatment where pelleted grower was scattered in the litter. All pens were equipped with a bell drinker, which was later replaced with a cup drinker, a feed trough, and an infrared heating lamp. The floor was covered with an approximately 7 cm layer of wood shavings. Whenever the litter became dirty or wet, fresh wood shavings were added equally to all pens. Birds had ad libitum access to water and feed. They were fed a two-phase diet including a non-pelleted starter (12.4 MJ ME/kg, 23.27% CP, 1.10% Ca, 0.81% P) from 1 to 12 days of age and a pelleted grower (12.5 MJ ME/kg, 21.35% CP, 1.00% Ca, 0.73% P) from 12 days of age till slaughter. An artificial lighting program with 23 h L : 1 h D (darkness was between 19:00 and 20:00 h) was provided. The temperature in the pens was maintained at about 32°C at the first day and was gradually decreased to approximately
19°C at the end of the growing period. At 27 days of age, three chickens were randomly removed from each pen to increase birds' possibility to walk. Although stocking density was lower than in commercial broiler production, at 27 days of age birds already occupied almost the entire pen floor and thus reduced the possibility to walk. Six animals coming from two pens, each of the same treatment, were housed in additional six pens, so in total the experiment comprised 18 pens (six per treatment) with 6 (in four of the 12 original pens where one of the birds died and in the six additional pens) or 7 (in eight of the original pens where there was no losses yet) animals in each. Ninety animals (27 C, 26 P, and 37 W) were slaughtered at 39 days of age. Twenty-four birds, 12 from the C and 12 from the P treatment, which were at 37 days the closest to the treatment's body weight average, were kept for prolonged fattening. Up to 39 days of age three animals died (1C at 2, 1P at 6 and 1P at 8 days of age), and three were culled due to leg problems (1C at 20 and 2W at 37 days of age).

**Experimental treatments**

The study consisted of three feeding treatments:

a) A conventional feeding program fed ad libitum (C) with the feed available in the trough refilled every morning at 06:00 h.

b) The wheat scatter treatment (W), where the experimenter scattered wheat on the litter at 06:00 and 18:00 h from day three onward. The quantity of wheat was gradually increased every week, from 1 to 8 g per bird from day 3 to 39 (the first week 1 g per bird, in the second 2 g, and then increased by 2 g per bird each next week up to 8 g). Feed was available ad libitum in the trough refilled every morning at 06:00 h.

c) The P treatment, where pellets of the same diet as feed in the C and W treatment were scattered in the litter from 14 days of age on, when the feed troughs were removed from the pens. The start of this treatment was conditional on the beginning of feeding birds with pelleted feed. The daily quantity of pelleted grower, which was calculated from feed consumption in the control treatment daily, was divided in five equal portions and scattered on the litter by the same experimenter at 06:00, 10:00, 14:00, 18:00, and 22:00 h.

**Measurements and behavioural observations**

Live weight per pen was recorded weekly, but the feed consumption per pen was recorded in total for two periods (from 1-27 and 28-39 days of age) due to redistribution of birds at the age of 27 days. Because it was not possible to measure the amount of scattered feed eaten, only the feed consumption from the feed trough was considered. This was only possible in the C and W treatment, whereas in the P treatment we were not able to determine how much of the pellets offered in the litter the birds actually ate and how much remained in the litter. Similarly in the W treatment we were not able to determine the amount of wheat remaining in the litter, therefore wheat was not included in the calculation of consumed feed. Prior to the slaughter animals were individually weighted. Any birds that died during the experiment were weighed and their weight gain was included in calculation of feed conversion ratio.

The behaviour of broilers was recorded continuously from the second week of age in the original 12 pens between 05:00 to 07:30 h. This period was chosen because at 06:00 h all the birds received fresh feed, whether in the trough or in the litter, so the effect of novel feed on the behaviour of birds was the same in all treatments. Besides, the hour before feed distribution was assumed to represent the most inactive period of the day while the hour after feed delivery was assumed to represent the most active period of the day and thus the period in which possible differences between treatments should be revealed. The behaviour of birds was recorded using four video cameras plugged on the PC via Digi-Protect video surveillance card (ABUS Security Tech Germany). Four pens were recorded simultaneously, so three recording days were needed to complete one observation day for all 12 pens. Because the P treatment started at 14 days of age, the behaviour of the birds in this treatment was recorded from the third week of age onwards. Recording was carried out four times at 9 and 10, 16 to 18, 23 to 25, and 30 to 32 days of age. Video records were analysed using scan sampling at 05:00, 05:30, 06:00, 06:30 and 07:00 h with counting the number of animals performing particular behavioural pattern. At the stated hours a series of 10 scans in 60 s interval was performed, so in 2.5 hours we did altogether 50 scans per pen. The following mutually exclusive behavioural patterns were recorded: lying (lying with doing nothing else), standing (standing without performing any other behavioural pattern), walking, feeding (pecking at the feed in the feed trough; this behavioural pattern could only be recorded in the C and W treatment), drinking, scratching (including dust bathing, which was observed seldom), and pecking (including pecking of the litter in all treatments, wheat in the W treatment and feed pellets in the P treatment).

**Statistical analysis**

Statistical data analysis was conducted using statistical program package JMP version 7.0 (SAS, 2007). For all analysed data, the pen was the experimental unit. The effect of treatment on weight gain, feed intake, conversion and body weight was analysed by one-way ANOVA. When the effect was significant (P < 0.05) differences between means were tested by Student's multiple t-test.

Behavioural data were not normally distributed. Therefore they were analysed with non-parametric statistics. Treatment effect within each week of age was tested with the Kruskal-Wallis test followed by the Mann Whitney U test for pairwise comparison of means.

**Results**

**Bird growth and feed conversion**

Feed intake and feed conversion are presented only for the C and W treatment (Table 1), because it was not possible to measure how much of the feed scattered in the litter the P birds actually consumed. Wheat scattered in the litter additionally to the complete feed mixture had no significant influence on feed intake in the W treatment (wheat was not included in the amount of feed consumed). However, broilers' growth was significantly influenced by the environmental enrichment from 15 to 39 days of age (Table 2), with the P birds growing significantly slower compared to the C and W birds, which resulted in 13% lower slaughter weight.

**Behaviour**

Broilers spent most of the observation time lying (Table 3). Birds in the C and W treatment were lying more than 50% of observation time from the second week of age onwards. The percentage of time spent lying increased with the age, while the percentage of active behaviours (walking, feed-
ing, scratching) decreased. A small quantity of whole wheat scattered in the litter additionally to complete feed mixture offered ad libitum in the trough had no influence on observed behavioural patterns regardless the birds’ age (Table 3). On the contrary, scattering feed pellets in the litter significantly influenced the percentage of time birds spent lying, walking, scratching and pecking. Compared to the C and W birds, P birds spent significantly less time lying, walking, scratching and pecking. Thus a part of the pellets may have not completely consume the amount of feed scattered. After the distribution of the feed, it is obvious that the birds did not find a significant change in feed conversion when broilers at fifth week of age is about 2.34 MJ (0.18 kg × 13 MJ/kg of concentrate), the energy requirement for walking and running of laying hens has been determined by van Kampen (1976). Depending on the speed the extra energy for walking varied between about 10 to 15 J/h per g of body weight. Given the mean body weight of the P birds at 5 weeks of age of 1913 g (Table 2), the time spent walking of 1.748 h/day (7.6% of 23 h of light) (Table 3), and an energy requirement for walking of 15 J/h per g of body weight the extra energy requirement for walking was 50159 J/day or 0.05 MJ/day. Considering the total energy intake of broilers at fifth week of age is about 2.34 MJ, the energy requirement for this behaviour is 2.14% and cannot be the main cause of the lower growth rate of the P birds. This is also supported by experiments of Rütten (2000), who could not find a significant change in feed conversion when broilers were subject to exercise on a treadmill. It has to be assumed that a considerable part of the feed has been lost in the litter. Although the birds accepted pelleted feed scattered in the litter spontaneously, and the experimenter could not find whole pellets in the litter several hours after the distribution of the feed, it is obvious that the birds did not completely consume the amount of feed scattered. After scattering of the pellets birds showed high activity of scratching and pecking. Thus a part of the pellets may have been destroyed and the fine particles could not be recovered by the birds. The fact that scattering whole wheat in

### Discussion

**Bird growth and feed conversion**

Growth and feed conversion rate the C and W birds developed in line with the standard of Ross 308 as provided by the breeder (Ross, 2007). The reduced growth rate of the P birds could be caused by the higher energy requirement for walking, scratching, and pecking or lower feed intake. The energy requirement for walking and running of laying hens has been determined by van Kampen (1976). Depending on the speed the extra energy for walking varied between about 10 to 15 J/h per g of body weight. Given the mean body weight of the P birds at 5 weeks of age of 1913 g (Table 2), the time spent walking of 1.748 h/day (7.6% of 23 h of light) (Table 3), and an energy requirement for walking of 15 J/h per g of body weight the extra energy requirement for walking was 50159 J/day or 0.05 MJ/day. Considering the total energy intake of broilers at fifth week of age is about 2.34 MJ, the energy requirement for this behaviour is 2.14% and cannot be the main cause of the lower growth rate of the P birds. This is also supported by experiments of Rütten (2000), who could not find a significant change in feed conversion when broilers were subject to exercise on a treadmill. It has to be assumed that a considerable part of the feed has been lost in the litter. Although the birds accepted pelleted feed scattered in the litter spontaneously, and the experimenter could not find whole pellets in the litter several hours after the distribution of the feed, it is obvious that the birds did not completely consume the amount of feed scattered. After scattering of the pellets birds showed high activity of scratching and pecking. Thus a part of the pellets may have been destroyed and the fine particles could not be recovered by the birds. The fact that scattering whole wheat in
the litter did not show any effect on growth rate and feed conversion is in the agreement with findings of BIZERAY et al. (2002b). The authors reported no significant effect on body weight and feed conversion rate when wheat was scattered from 8 and 17 days of age. The missing effect of this treatment in the present study is obviously due to the fact, that the birds ate as much standard diet as the C birds.

Broilers in this regard differ in their feeding behaviour from laying hens, which show a high preference for whole grain, especially when it is scattered in the litter (APPLEBY et al., 1995). In the present study walking, scratching, and pecking were significantly increased only when the entire diet was scattered in the litter, although one hour after feed scattering these behavioural patterns already considerably decreased. Nevertheless, the relatively high level of these behaviours shows that the birds are capable to perform active behaviour at a higher level when this is necessary to meet their nutrient requirements. Broilers capability of walking was also proven by REITER and BESSEI (1998) and RUTTEN (2000), who increased the locomotive activity in broilers by the use of a treadmill. The walking ability of broilers on the treadmill was higher than their spontaneous activity in the home pen. Further experiments showed that the reduced activity of broilers is mainly influenced by the weight load on the legs: the locomotor activity of fast growing broilers was tripled when the weight load on the legs was reduced by about 20% with a balance and the locomotor activity of slow growing broilers was reduced when the load on their legs was increased with the lead weights (DJURK STOJIC and BESSEI, 2008).

Boilers appear to have little or no motivation for foraging behaviour as long as they can meet their nutrient requirements through easily available feed in the feeder. The behaviour of broilers differs in this regard from that of layer lines and layer×broiler crosses which show intensive foraging behaviour when mash or pelleted feed is offered in the trough (SAROVY and MANN, 1997). When laying hens were offered feed in an operant conditioning situation, they continued to work for feed even when feed was freely available (DUNCAN and HUGHES, 1972). In the present study walking, scratching, and pecking were significantly increased only when the entire diet was scattered in the litter, although one hour after feed scattering these behavioural patterns already considerably decreased. Nevertheless, the relatively high level of these behaviours shows that the birds are capable to perform active behaviour at a higher level when this is necessary to meet their nutrient requirements.

The behavioural profile of fast growing broilers is characterized by a low level of active behaviours, such as walking, feeding, and scratching and a high level of inactive behaviours such as lying, sitting, and standing. There is a general decrease of active behaviours and increase of inactive behaviours from the first week of age towards the end of the fattening period (BESSEI, 1992b; SCHEIER, 1989). The behaviour of the broilers in the C and W treatment showed agreement in the level and trend over age with the above mentioned studies. In fact there was no significant difference between the C and W birds in any of the observed behavioural pattern (Table 3). This shows that scattered wheat in the litter did not stimulate foraging behaviours, such as walking, scratching, and pecking. Also BIZERAY et al. (2002a) did not observe any effect on broilers activity due to whole wheat scattered in the litter.
increment of active behaviours walking, scratching and pecking in the P birds was probably the result of both, the feeding method and slower growth. With the removal of feed troughs and scattering the entire diet in the litter, feed was no longer easily accessible and birds were forced to search in the litter. Due to the fact, that some feed pellets could not be recovered by the birds, it cannot be excluded that hunger probably presented an additional stimulation for birds to be more active in search for feed. This is supported by the study of NIELSEN et al. (2003), who reported that quantitative feed restriction stimulated activity in fast growing broilers. Another contributing factor to the higher activity level observed in the P birds was, according to the previous studies, probably the slower growth and consequently reduced weight load on the P birds’ legs compared to the C and W birds (BOKKERS and KOENE, 2003; DJUKIC STOJIC and BESSEI, 2009; REITER and BESSEI, 1998; REITER and KURTITZ, 2001).

Conclusions

Our results clearly show that the main motivation for locomotor activity in broilers is driven by their requirement for feed. Scattering pellets in the litter seems to be a promising method to induce broilers’ activity and thus contributes to their welfare due to possible decrement of leg problems. However, the problem of slower growth needs to be solved as well as how this method could be efficiently implemented into practice. Whole wheat as the addition to standard diet did not have such an effect.

Summary

The objective of this study was to enhance the locomotor activity of fast growing broilers by stimulation of foraging behaviour. The study included 120 Ross 308 broiler chickens of mixed sex fattened from 1-39 days of age in small groups (10 birds/group from 1 to 27 and 6-7 birds from 27 to 39 days of age). Chickens were randomly allotted to one of three treatments (four groups/treatment). The control birds (C) were fed with a complete feed mixture offered in a trough, W birds additionally to the feed in a trough received a small quantity of whole wheat scattered twice a day in the litter, and in the P treatment the trough was removed at 14 days of age and pelleted grower was scattered in the litter five times a day. Feed intake and feed conversion were similar in the C and W treatment. In the P treatment it was not possible to measure how much of the pellets offered in the litter the birds actually ate and how much remained in the litter. From 15 to 39 days of age the P birds grew significantly slower compared to the C and W birds, which resulted in 13% lower slaughter weight (C: 66.1 ± 5.5 g, P: 1913 ± 64 g). P birds spent significantly (P < 0.05) less time lying in the third (P: 33.7 ± 5.0%, C: 66.1 ± 2.6%, W: 61.0 ± 1.5%) and fourth week (23.0 ± 6.8%, C: 62.3 ± 4.0%, W: 56.9 ± 6.1%) of age compared to the C and W birds, whereas this difference disappeared in the fifth week. Birds from the P treatment walked for a longer time than C and W birds from the third week onwards. They showed also more scratching and pecking. Scattering feed pellets in the litter significantly increased broilers activity, which was not achieved with the whole wheat scattered in the litter. Scattering pellets in the litter seems to be a promising method to enhance broilers’ activity and thus contributes to their welfare. However, improvements should be brought to avoid that feed loss and reduction of growth rate.

Key words

Broilers, environmental enrichment, behaviour, performance, animal welfare

Zusammenfassung

Einfluss des Streuens von Weizenkörnern und Futterpellets in die Einstreu auf die Bewegungsaktivität von Broilern


Stichworte

Broiler, Umweltanreicherung, Verhalten, Produktivität, Wohlbefinden

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