Locomotor problems in broilers reared on new and re-used litter

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Abstract

Two field trials were conducted to assess locomotor problems in broilers. Males and females broilers were used from two commercial strains reared on two different litter materials, new and re-used. In the first experiment (E1) rice husks and wood shavings were used as new litter, and in the second experiment (E2) the same litter was re-used. A batch of one-day-old chicks (2968) was reared randomly distributed in experimental pens, in a 2x2 factorial scheme (two genetic strains, two sexes and two litter materials). The same fodder and water were available to all birds ad libitum. Broilers locomotion problems were evaluated using the characteristics of gait score, incidence of valgus and varus, foot-pad lesions, degeneration, femoral, tibial dyschondroplasia, spondylothesis and breast calluses. The number of birds with high gait score was less than 50% in the two experiments. Males presented higher gait score (GS) (28.46% GS 1 and 2 compared to females, 20.98%); greater incidence of angular deformities (26.62% with varus compared to 14.71% of the female); and femoral degenerative joint lesions (70.83% in average, compared to 55.16% of the female), and the correlation between these traits varied from 0.18 to 0.87 (P<0.05). There was an increase of foot-pad lesions in re-used litter leading to poor welfare. The use of rice husks in deep litter for broiler production might be a viable alternative of wood shavings.

Introduction

Locomotion problems are particularly relevant for the poultry industry. Limited mobility is usually related to poor performance and lack of welfare status of lame birds. Brazilian regulation requires the assessment of broilers’ welfare which involves the evaluation of the gait score and the examinations of other traits carried out on the slaughter line, such as the occurrence of foot-pad lesions, calluses breast, and bone fractures that can lead to disqualification of the flocks for the market. Femoral degenerative joint lesions together with femoral degenerative joint lesions, tibial dyschondroplasia and spondylothesis are the main causes of anomalies associated with lameness in broilers (Julian, 2005; Paixão et al., 2007; Nääs et al., 2009). Many symptoms arising from bone abnormalities are not clinically detectable, making difficult the quantification of the carcass damages.

There is evidence that some genetic strains of broilers show decreased mineralization and increased porosity of the bones (Williams et al., 2000). Weaker bones are more susceptible to fractures occurred during capture and transport leading to pain and carcass condemnation. Preventing bone abnormalities is beneficial to improve birds’ welfare, and it may reduce commercial losses (Garner et al., 2002). It is possible to develop new broiler rearing management and ensuring appropriate levels of productivity and product quality without putting the welfare of birds at risk. Locomotor problems may be minimized by the use of appropriate management of litter, adequate diet and control of ambient temperature (Keirstin et al., 1992; Dawkins et al., 2004).

This research aimed to assess the impact of the litter used in broiler production on the incidence of locomotor problems and welfare in males and females, in two commercial strains of broiler chickens.

Materials and methods

Two field trials were conducted (E1 and E2) in an experimental broiler house, in the Southern region of Mato Grosso do Sul, Dourados, Brazil, at latitude of 22°11’S, longitude of 54°56’W and altitude of 217.77 m. The avaries were East-West oriented and had a concrete floor with a slope of 2.5%. Bell drinkers and tubular feeders were used. The houses had open sides and closed walls at the ends. Lateral openings were covered with yellow polypropylene (170 µm) curtains that could be wrapped up when required, and the house air exchange and circulation was done by using axial fans placed along the center of the house, and it was associated with fogging when cooling was needed.

Two types of bedding material were used in the experiments: E1 had new rice husks and new wood shavings, and E2 used both materials as re-used deep litter. Environment temperature and relative humidity were recorded using a data logger in the geometric center of the house.

The experimental procedure was approved by the Ethical Committee of UFGD, protocol number 903/2010.

Birds and husbandry

In each experiment, 2968 one-day-old chicks were used, being 742 male and 742 female pullets from genetic strain A, and 742 male and 742 female pullets from genetic strain B. Birds were housed on new deep litter (5 cm) of wood shavings in 50% of the boxes, and rice husks in the remaining 50%, up to 45 days of growth. The birds were distributed in boxes with an area of 4.5 m² resulting in a flock density of 11.8 birds m⁻². Insufficient fodder and water were available to all birds ad libitum. The experimental design was randomized in a 2x2x2 factorial consisting of two genetic strains, two sexes, two bedding materials (wood shavings and rice husks), which made a total of eight treatments with seven replications (53 animal for replicate). Locomotor problems and welfare of birds were evaluated through the assessment of gait score, incidence of calucus and varus, foot-pad lesions, femoral degenerative joint lesions, tibial dyschondroplasia, spondylothesis and breast calluses.

The assessment of gait score and calucus and varus deformities were done inside the aviary.
Birds were randomly selected for these evaluations (120 birds for gait scoring and 60 birds for the remaining evaluations — it was used 50% of the birds evaluated for the gait score, independently of the repetition). After the birds were slaughtered, the following traits were assessed: femoral degenerative joint lesions, tibial dyschondroplasia, callous breast, spondylolisthesis and foot-pad lesions.

Assessment of gait score, valgus and varus deformity and foot-pad lesions

The assessment of gait score (GS) consisted of observing the birds which were stimulated to walk a distance of 1 m (Cordeiro et al., 2009; Nääs et al., 2009). Each bird was scored using a gait score system, which uses four levels of walking ability as suggested by Dawkins et al. (2004): 0, sound bird that walks ten steps normally; 1, average bird that walks ten steps with some degree of difficulty and presents some unbalance during walking; 2, lame bird that walks with considerable difficulty and sits after 1 to 4 steps. GS was evaluated in individual birds by a trained observer.

The evaluation of varus and valgus deformities (V) were performed using a caliper and a protractor to measure the angle between the tibia and three toes on the right and left legs. When the angle was negative varus deformity was characterized, and when the angle was positive the deformity valgus was characterized. The trait foot-pad lesion (FPL) was analyzed using a scale with three levels according to the presence or severity of the lesion in both feet. These scores ranged from no foot-pad lesions (score 0), over mild lesions (small injury detected up to 5 mm in diameter - score 1), to severe lesions (severe foot-pad lesions, with a diameter larger than 5 mm - score 2), as presented by Almeida Paz et al. (2010).

Assessment of femoral degenerative joint lesions, tibial dyschondroplasia, spondylolisthesis and breast calluses

The femoral head degeneration of the right and left femur were analyzed and scored. The analysis was performed macroscopically in both legs by examining the thickness of cartilage and bone growth. Scores were given ranging between 0 and 2. Score 0 corresponded to the absence of injury; score 1 was attributed when initial injury was detected, and score 2 indicated a femoral head severely injured (Almeida Paz et al., 2008).

The prevalence of spondylolisthesis (ES) was accessed by analyzing the integrity of the vertebrae. The back was sawed along the spine in the midline with a handsaw. The birds were classified as having or not the deformity which presents deviation on the column (Paixão et al., 2007). After slaughter, the skin in the pectoral area was removed, and the region was visually analyzed for the identification of calluses and bruising.

Statistical analysis

Data were analyzed using Shapiro-Wilk test to verify the normality of residuals, and Levene test for the homogeneity of variances. ANOVA was applied to data and comparisons of the results were done using the Kruskal-Wallis test (P<0.05). When the effects were significant they were tested with the χ² test, and when the expected frequencies were lower than 5 the Fisher test was applied. In addition, simple correlations between variables were tested using the Spearman test at a significance level of 5%. Calculations were processed using the software SAS (2004).

Results and discussion

In both field trials records the ambient temperature ranged from 34°C to 26.5°C, and the relative humidity from 58% to 82%. Mortality value found in E1 for genetic strain A was 3.8%, and 4.2% for genetic strain B. The mean weight at slaughter of genetic strain A was 2850 g for males and 2700 g for females. Males of genetic strain B had an average weight at slaughter of 2970 g, and females presented 2740 g. During E2, the mortality found for genetic strain A was 3.5%, and for genetic strain B it was 4.0%. The mean weight at slaughter of genetic A was 2830 g for males, and 2720 g for females. Males from genetic strain B presented an average weight at slaughter of 2990 g and females of 2710 g. It was assumed that the genetic strain A presented a slower growth rate than genetic strain B.

As seen in Table 1, gait score was influenced by sex (P=0.0001). The incidence of abnormality (varus and valgus) in the left leg (VL) was also influenced by sex (P=0.05). The prevalence of FPL [right (RC) and left (LC)] was influenced by the litter (P=0.0001).

![Figure 1. Gait score and prevalence of spondylolisthesis in broilers 45 days old reared at new and re-used litter (n = 60 in each experiment for all studied variables, P<0.05).](image1)

![Figure 2. Incidence of locomotor problems in broilers 45 days old, with gait score 1 and 2, reared on new and re-used litter (n = 60 in each experiment for all studied variables, P<0.05).](image2)
Dawkins et al. (2004) indicates that not only stocking density, but also a wide range of rearing conditions, including factors like ambient temperature, humidity, and litter moisture, influences leg health and welfare of broilers. The moisture content of the litter can have considerable influence on the incidence and severity of FPL mainly in re-used litter. Results from this experiment showed high prevalence of footpad lesions in the birds reared on re-used litter of wood shavings. Similar results are reported by Wang et al. (1993) when compared the incidence of foot-pad lesions in birds reared on dry and wet beds, and found that broilers reared on a dry litter had a lower prevalence of FPL when compared to those on wet litter (Smith, 1956; Traldi et al., 2007). No difference in the incidence of FPL was found related to sex or genetic strain, differing from the results presented by Kapell et al. (2012). However, in a large epidemiological study carried out by Ekstand et al. (1997) no difference was found in the prevalence of FPL in two distinct genetic strains.

Males presented higher GS compared to females (Table 2, P<0.05), possibly since males were heavier than females at all ages. The results of the present experiment did not indicate that fast grower genetic strain may lead to walking problems, differing from Bokkers and Koene (2004) who found that growth rate seems to influence broiler’ walking ability. Incidence of gait scores 1 and 2 were higher in males reared to influence broiler’ walking ability. Incidence of FPL in two distinct genetic strains. Koene (2004) who found that growth rate seems to influence broiler’ walking ability. Incidence of gait scores 1 and 2 were higher in males reared to influence broiler’ walking ability.

The experiment and sex presented some effect on angular deformities of the legs (P<0.05; Table 4). There was a higher incidence of deformities in birds reared on new litter (35.83%) and left deformities in males (26.6%). These deviations were characterized by lateral deviation (valgus) or medial deviation (varus) of one or both legs. Amongst the deviations, it was found a higher degree of lateral deviation (valgus). Similar results were reported by Leterrier and Nys (1992) who found higher incidence of valgus in males. According to Gonzales and Mendonça Jr. (2006), the angular deformity (varus-valgus), occurs due to a genetic abnormality, especially in fast growth broilers, which was not observed in the present study.

There was an effect of sex on the incidence of femoral degenerative joint lesions (P<0.05) and increased the frequency of FDL in the new litter (Table 5). Males presented higher frequencies in both legs (FDL and FDR); however, Almeida Paz et al. (2008) studying bone mineral density of birds with femoral degenerative joint lesions found that this injury is not related to sex and genetic strain, differing from the results found in this study. Moreover, the incidence of FDL and FDR (Table 5) was found to be high, agreeing with other studies (Bains et al., 1998; Almeida Paz et al., 2009).

### Table 1. P values of the effects of the nonparametric variables studied.

| Experiment | Litter | Sex | Genetic strain |
|------------|--------|-----|----------------|
| Gait score  |        | ns  | 0.0001         |
| Spondylolisthesis |        | ns  | 0.0001         |
| Lateral deviation right |        | ns  | 0.0001         |
| Lateral deviation left |        | ns  | 0.05           |
| Femoral degenerative joint lesions (right) |        | ns  | 0.0001         |
| Femoral degenerative joint lesions (left) |        | ns  | 0.01           |
| Tibial dyschondroplasia (right) |        | ns  | 0.0001         |
| Tibial dyschondroplasia (left) |        | ns  | 0.0001         |
| Foot-pad lesion (right) |        | 0.0001 | 0.0001 |
| Foot-pad lesion (left) |        | 0.0001 | 0.0001 |

ns, not significant.

### Table 2. Frequency of gait score (%) for male and female broilers from two genetic strains reared on two types of litter (new and re-used).

| Score | Experiment | Litter material | Sex | Genetic strain |
|-------|------------|-----------------|-----|----------------|
|       | E1         | E2              | R   | W  | M  | F  | A   | B   |
| 0     | 80.34      | 78.29           | 79.84| 78.71| 71.54<sup>6</sup>| 86.99<sup>6</sup>| 79.01 | 79.52 |
| 1     | 14.10      | 16.67           | 15.64| 15.26| 21.14<sup>6</sup>| 9.76<sup>6</sup>| 14.81 | 16.06 |
| 2     | 5.56       | 5.04            | 4.53 | 6.02 | 7.32<sup>6</sup>| 3.25<sup>6</sup>| 6.17  | 4.42  |

E1, new litter; E2, re-used litter; R, rice husk; W, wood shavings; M, male broilers; F, female broilers. *Means with different superscripts within the columns differ by Kruskal-Wallis test (P<0.05).

### Table 3. Frequency of spondylolisthesis (%) in male and female broilers from two different genetic strains reared on two types of litter (new and re-used).

| Score | Experiment | Litter material | Sex | Genetic strain |
|-------|------------|-----------------|-----|----------------|
|       | E1         | E2              | R   | W  | M  | F  | A   | B   |
| 0     | 67.52<sup>6</sup> | 93.55<sup>6</sup>| 66.46| 65.59| 66.05| 66.03| 67.08 | 64.90 |
| 1     | 32.48<sup>6</sup> | 6.45<sup>6</sup> | 33.54| 34.42| 33.95| 33.97| 32.92 | 35.10 |

Score 0, without lesion; score 1, with lesion; E1, new litter; E2, re-used litter; R, rice husk; W, wood shavings; M, male broilers; F, female broilers. *Means with different superscripts within the columns differ by Kruskal-Wallis test (P<0.05).
There was no effect of the bedding type/material, sex and genetic strain on the prevalence of tibial dyschondroplasia. The frequency of TDL and TDR was low, which are similar to those found in the literature (Rath et al., 1998; Praul et al. 2000; Almeida Paz et al., 2005; Almeida Paz et al., 2009). The experiment with litter of re-used wood shavings presented an increase in lesions of RC and LC.

The correlations between the locomotor problems in broilers confirm the association between GS and the traits (0.18); VL and RL (0.21); FDL and FDR (0.55), and LC and RC (0.87). The association between GS x VL despite low it may be an indication of limited mobility due to the lateral deviation of the birds’ legs whether varus or valgus. In their studies Sanotra et al. (2001) also found a positive correlation between GS and valgus deformity. The remaining correlation between locomotor problems (VL x VR, FDL x TDR and RC x LC) are from bilateral lesions; however, it may appear initially in unilateral form. The birds’ walking discomfort by the overload of one limb may not directly affect the injury, but it may cause development of bilateral lesion over the period of rearing. Femoral degenerative joint lesions occur in young animals and have no defined etiology. It may be unilateral or bilateral, resulting in changes not only in the femoral head, but also in the femoral neck (Kealy, 1987). Results from this experiment are similar to those described in current literature (Paixão et al., 2007; Almeida Paz et al., 2009).

The frequency of the studied injuries in broilers with gait score 1 and 2 varied as the litter was new or re-used (Figure 1). There was an increase in the incidence of lesions in the footpad (RC and LC), in the re-used litter, and a reduction in the frequency of ES, and TDR and TDL, in the experiment with re-used litter. The males showed an increase in GS 1 and 2 and lower prevalence of ES in re-used litter (Figure 2). Spondylolisthesis is a disease that affects broiler males and females of rapid growth (Gonzales and Mendonça Jr, 2006), and the fast development of the pectoral muscle may lead to this pathology. No breast callus was found during the evaluation of carcasses after slaughter in these experiments, similar to the results described by Brake et al. (1993) and Willis et al. (1997). Leg abnormalities may result in lameness, which leads to the decrease in the access to feeding and drinking, and it modifies broiler

### Table 6. Frequency of foot-pad lesions in the right and left foot for male and female broilers from two genetic strains and reared on two types of litter (new and re-used).

| Score | Experiment | Litter material | Sex | Genetic strain |
|-------|------------|----------------|-----|----------------|
|       | E1         | E2             | R   | W             | M   | F   | A | B |
| 0     | 78.25a     | 46.75b         | 74.68 | 52.29b        | 61.54 | 65.81 | 68.32 | 58.67 |
| 1     | 8.28b      | 14.94c         | 12.05 | 11.11c        | 11.54 | 11.61 | 11.80 | 11.33 |
| 2     | 11.46b     | 38.31c         | 12.05 | 36.69b        | 26.92 | 22.58 | 19.88 | 30.00 |

RC, foot-pad lesions in the right foot; LC, foot-pad lesions in the left foot; E1, new litter; E2, re-used litter; R, rice husk; W, wood shavings; M, male broilers; F, female broilers. *Means with different superscripts within the columns differ by Kruskal-Wallis test (P<0.05).

### Table 4. Frequency of lateral deviation in the right and left leg for male and female broilers from two genetic strains and reared on two types of litter (new and re-used).

| Score | Experiment | Litter material | Sex | Genetic strain |
|-------|------------|----------------|-----|----------------|
|       | E1         | E2             | R   | W             | M   | F   | A | B |
| 0     | 64.17a     | 81.29b         | 75.91 | 71.74         | 71.22 | 76.47 | 73.57 | 74.07 |
| 1     | 35.83b     | 18.71b         | 24.09 | 28.26         | 28.78 | 23.53 | 26.42 | 24.44 |
|       | 75.83a     | 81.94b         | 78.83 | 79.71         | 73.38b | 85.29b | 82.14 | 76.30 |
| 1     | 24.17b     | 18.06a         | 21.17 | 20.29         | 26.62b | 14.71b | 17.86 | 23.70 |

VR, lateral deviation in right leg; VL, lateral deviation in left leg; score 0, no lateral deviation; score 1, with lateral deviation; E1, new litter; E2, re-used litter; R, rice husk; W, wood shavings; M, male broilers; F, female broilers. *Means with different superscripts within the columns differ by Kruskal-Wallis test (P<0.05).

### Table 5. Frequency of femoral degenerative joint lesions in the right and left leg for male and female broilers from two genetic strains and reared on two types of litter (new and re-used).

| Score | Experiment | Litter material | Sex | Genetic strain |
|-------|------------|----------------|-----|----------------|
|       | E1         | E2             | R   | W             | M   | F   | A | B |
| 0     | 27.39      | 46.10          | 39.87 | 36.60         | 28.85a | 34.19a | 25.37 | 38.00 |
| 1     | 45.22      | 17.53          | 26.58 | 30.07         | 40.38a | 23.23a | 33.54 | 39.00 |
| 2     | 26.75      | 29.22          | 29.11 | 26.80         | 37.18b | 18.71b | 32.30 | 23.33 |

FDR, femoral degenerative joint lesions in the right leg; FDL, femoral degenerative joint lesions in the left leg; E1, new litter; E2, re-used litter; R, rice husk; W, wood shavings; M, male broilers; F, female broilers. *Means with different superscripts within the columns differ by Kruskal-Wallis test (P<0.05).
behavior (Weeks et al., 2000). It is believed to be the most serious welfare problem in modern broiler production as it provokes pain and discomfort in the intensively reared poultry. According to Webster et al. (2008) fear or novelty can cause the chicken to ignore the pain condition, and it may walk or run normally. When the birds are encouraged to walk, they make a considerable effort to meet the task, and probably walk a distance greater than that they would walk without the stimulus, in conditions of pain or discomfort. The traits that may cause lameness in broilers were studied (FPL, ES, FDL, and V), and some have higher influence in the locomotor ability of birds, such as the incidence of foot-pad lesion, which is a painful injury to birds that may compromise their welfare status.

Conclusions

The prevalence of foot-pad lesions where found higher in the re-used litter than in the new litter material, leading to broilers’ lameness. Males presented higher gait score, occurrence of angular deformities, and femoral degenerative joint lesions than females, and the correlation between these traits varied from 0.18 to 0.87 (P<0.05). The use of rice husks in modified gait scoring system and its use in assessing tibial dyschondroplasia in broilers. Brit. Poultry Sci. 43:355-363.

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