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Number of flocks on the same litter and carcass condemnations due to cellulitis, arthritis and contact foot-pad dermatitis in broilers

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Abstract 1. This study was conducted to verify the impact of different kinds of material and the number of times of litter reuse on the incidence of chicken pathologies. Approximately 4.5 million broilers from conventional Brazilian farms were evaluated in the abattoir for cellulitis, arthritis and contact foot-pad dermatitis.

2. Four different kinds of litter material, *Brachiaria* grass, corncob, sawdust and rice shell, were used. *Brachiaria* grass litter showed the highest incidence of contact foot-pad dermatitis. Corncob litter also showed some negative effects on foot quality. Broilers raised on rice shell litter showed good results in terms of the incidence of contact foot-pad dermatitis. The best results were obtained with sawdust litter, because the incidence of cellulitis and arthritis were the lowest and the incidence of contact foot-pad dermatitis was also very low.

INTRODUCTION

Animal welfare, the environmental impact caused by intensive animal production and microbiological meat quality have become more important for international trade. These are factors that affect purchase decisions by consumers and create restriction barriers in several countries. The search for alternative solutions to solve this situation is an important point that will allow poultry production to be competitive from all points of view, including technological and economic. Skin injuries and lesions of different sizes may indicate that during the growth phase the birds suffered abuse, pain or poor welfare. These injured areas reflect losses on carcasses sold in retail outlets (Paganini, 2004; Broom and Reefmann, 2005).

The reuse of litter is a common practice in poultry production in some parts of the world. Although important economically, it is considered to be a particular problem when related to pathological diseases associated with close contact with faeces (Ito *et al.*, 2004;

Coufal *et al.*, 2006a). Dawkins *et al.* (2004) suggested that the environment provided for the birds affects welfare more than space availability.

Among the various pathologies related to close contact with faecal material, cellulitis is one of the most important, causing high losses in abattoirs around the world. It can lead to partial or total condemnation of carcasses, reducing the value of the final product. Injury results from the accumulation of exudates in the subcutaneous tissue of birds, mostly in the abdominal region. This condition is likely to be painful and hence associated with poor welfare (Schrader *et al.*, 2004).

Arthritis can also be related to poor litter quality. Many bacteria have been isolated from birds with this pathology: *Staphylococcus aureus*, *Escherichia coli*, *Salmonella* spp., *Pasteurella multocida* and *Pseudomonas* spp. The most frequent sign is the inflammation of the hock (tibiotarsus-tarsometatarsus).

Contact foot-pad dermatitis can be a gateway for the development of arthritis and is directly

related to the birds' welfare (Bradshaw *et al.*, 2002). This dermatitis, also litter related, produces high losses. Contact foot-pad dermatitis is caused by ammonia, excess moisture, heat and bacterial growth (Santos *et al.*, 2002; Hermans *et al.*, 2006). Other parts of the birds can be affected by contact dermatitis, especially those that are in constant contact with the litter. The initial inflammatory response is associated with a proliferative secondary component of the epidermal junction, which progresses to ulceration of the areas of friction, with overlapping secondary bacterial infection (Santos *et al.*, 2002).

In the present study we investigated the effects of the use of different types of litter and their reuse, reflected in the incidence of cellulitis, arthritis and contact foot-pad dermatitis, during broiler slaughter inspection.

MATERIALS AND METHODS

Broiler chickens (Cobb 500TM) from the same hatchery, reared on 4 types of litter, were evaluated from August 2004 to March 2005. Data on the incidence of cellulitis, arthritis and contact foot-pad dermatitis were collected at slaughter by examining carcasses condemned by federal inspection.

Data were collected from 12 farms (random sample), three using *Brachiaria* grass litter, three with corncob, three with rice shells and three with sawdust. *Brachiaria* grass and corncob were cut into 2–3 cm lengths of before use. Each farm was composed of production units (4 poultry buildings containing 22 000 birds each), with a total of approximately 88 000 birds per unit. The total analysed by type of litter was 264 000 birds (three farms). In each cycle, after litter disinfection, another 264 000 birds were housed and analysed for each type of litter.

In Brazil, for economic reasons, litter can be reused several times, provided that it is in a satisfactory condition and previous batches of birds did not present serious health problems. Inspections were performed over 8 m, sufficient to examine 4–5 batches of males or females per litter type. Broiler chickens were slaughtered at 34 (females) or 41 d (males), with median carcass weights varying from 1.5 (females) and 2.5 kg (males).

We used a scoring system to classify the carcasses with cellulites and arthritis for total or partial condemnation, and another system to consider the feet positive or negative for contact foot-pad dermatites. In the scoring system for cellulites, all the animals slaughtered were analysed by federal inspectors. Condemnation was partial when the affected area was the thigh or a small part of the abdominal or dorsal regions.

Condemnation was total when the affected area was such that it could not be removed from the rest of the carcass. For arthritis, the animals were also analysed by federal inspectors. Condemnation was partial when noticed joints were swollen, but could be removed, and was total when the affected areas could not be removed from the rest of the carcass without contamination.

We classified the feet as positive or negative for the presence of contact foot-pad dermatitis. When the dermatitis could not be easily removed, the feet were described as positive. Twelve samples of 100 carcasses were analysed per treatment and the results are as percentages.

The corncob litter was analysed separately because only female birds were used in this system, so fewer condemnations due to cellulitis were expected (females are lighter and spend less time in the production system).

Results were obtained from the sum of all condemned carcasses for cellulitis and arthritis, and the average incidence for contact foot-pad dermatitis. Data were analysed using the SAS[®] program. Because the coefficient of variation was large, the data were corrected using a different transformation method for each variation: the number of cases of total condemnation by arthritis and cellulitis was square-root transformed; for partial condemnations because of arthritis and cellulitis were log-transformed; and for foot-pad dermatitis percentage an arcsine transformation was used. Differences between means were tested using the Tukey mean significant difference test. Least-squared means were back-transformed per treatment.

The effect of treatment (rice shell, *Brachiaria* grass, corncob and sawdust litter) and number of times the litter was used, as well as their interactions on the occurrence (total, partial and per cent in 264 000 birds) of cellulitis, arthritis and contact foot-pad dermatitis were evaluated.

The general statistical model used was:

$$Y_{ijk} = \mu + T_i + L_j + TL_{ij} + e_{ijk}$$

where:

- Y_{ijk} = k th observation on the i th treatment of the j th litter repetition;
- T_i = i th effect of treatment (rice shell, *Brachiaria* grass, corncob and sawdust litter);
- L_j = j th number of litter uses (1, 2, 3, 4, 5);
- TL_{ij} = interaction of i th treatment with j th litter use;
- e_{ijk} = random error associated with each observation; and
- μ = overall mean.

RESULTS

The assessment of birds at the abattoir showed that when *Brachiaria* grass litter was used, entire carcass condemnations due to cellulitis were frequent. However, the number decreased as the litter was used more times. The opposite was observed for partial carcass condemnations for cellulitis (Table 1) where the frequency increased as the litter was reused. Carcass condemnations caused by arthritis were not large when compared with cellulitis, with no effect of repeated use observed.

Very high values were found for contact foot-pad dermatitis, with 67.9% for the first litter use. The pathology decreased with successive reuse up to 20.3% for the 4th reuse and 35% for the 5th, showing significant differences ($P < 0.05$).

For corncob litter, partial condemnations due to cellulitis varied between 0.5% in the first reuse and 5.9% for the last reuse, with significant differences. A difference was also noticed between the last reuse of corncob litter and the others, when the total condemnations due to arthritis were studied ($P < 0.05$). The values of partial condemnations for arthritis ranged between 72 and 1428 birds ($P < 0.05$). High values were found for contact foot-pad

dermatitis; 71.8% in the first use of the corncob litter and 46.1% in the last ($P < 0.05$).

For sawdust litter the three pathologies decreased in frequency as the litter was reused. This type of litter showed the fewest birds condemned due to cellulitis, arthritis (both total and partial), as well as the second lowest proportion of birds with pododermatitis.

Significant differences ($P < 0.05$) were observed for partial cellulitis with the first use of rice shell litter, with 2570 birds condemned at the time of inspection, and 7192 with the third use (Table 1). Contact foot-pad dermatitis occurred at a low frequency in this case.

Foot-pad dermatitis was frequent among broilers housed on the different types of bedding (Table 2). The lowest percentage of condemnation was on rice shell litter ($P < 0.05$). Differences between sawdust (second best result) and other treatments were also noted, with higher frequencies of contact foot-pad dermatitis on *Brachiaria* and corncob litter.

DISCUSSION

Different types of litter, used with 4 or 5 consecutive flocks, were studied. Other authors studying litter used for 9 (Coulal *et al.*, 2006a)

Table 1. Birds condemned in the abattoir for cellulitis, arthritis and contact foot-pad dermatitis, reared on different types of litter

Number of uses	Cellulitis			Arthritis			Contact foot-pad dermatitis (%)
	Total ^a	Partial ^b	Partial (%) ^c	Total ^a	Partial ^b	Partial (%) ^c	
<i>Brachiaria grass litter</i>							
1st	19	3121	1.18	1	973	0.37	68 ^A
2nd	13	5355	2.03	1	738	0.28	57 ^{AB}
3rd	16	5513	2.09	10	1021	0.39	46 ^{BC}
4th	13	5445	2.06	0	629	0.24	20 ^D
5th	13	8681	3.29	6	1438	0.54	35 ^{CD}
<i>Corn cob litter</i>							
1st	24	4861 ^{AB}	1.84	0 ^B	1428 ^A	0.54	72 ^A
2nd	1	1208 ^B	0.46	0 ^B	72 ^B	0.03	44 ^B
3rd	26	2465 ^B	0.93	0 ^B	138 ^B	0.05	49 ^B
4th	64	15 684 ^A	5.94	21 ^A	1260 ^A	0.48	46 ^B
<i>Sawdust litter</i>							
1st	21	6274	2.38	5	769	0.29	31
2nd	6	4209	1.59	5	653	0.25	46
3rd	7	2938	1.11	3	310	0.12	31
4th	9	2862	1.08	0	312	0.12	25
<i>Rice shell litter</i>							
1st	1	2570 ^B	0.97	0	495	0.19	29
2nd	11	4252 ^{AB}	1.61	4	646	0.24	19
3rd	14	7192 ^A	2.72	0	657	0.25	13
4th	11	6027 ^{AB}	2.28	0	603	0.23	14
Coefficient of variation (CV) (%)	21.28	9.63		9.41	15.94		24.88

Numbers followed by different capital letters in the same column differ at the 5% probability level ($P < 0.05$).

Approximately 1.052 million birds were assessed.

^aNumber of carcasses of birds condemned in their entirety.

^bNumber of carcasses of birds partially condemned.

^cPercentage of the total number of birds slaughtered that were partially condemned.

Table 2. Comparison between *Brachiaria* grass, corncob, sawdust and rice shell litters for contact foot-pad dermatitis condemnation

Number of uses	<i>Brachiaria</i>	Corncob	Sawdust	Rice shell
1st	0.969 ^A (68)	1.013 ^A (72)	0.590 (31)	0.569 (29)
2nd	0.856 ^{AB} (57)	0.725 ^B (44)	0.745 (46)	0.451 (19)
3rd	0.745 ^{BC} (46)	0.775 ^B (49)	0.590 (31)	0.369 (13)
4th	0.464 ^D (20)	0.745 ^B (46)	0.524 (25)	0.384 (14)
5th	0.633 ^{CD} (35)	–	–	–
Mean	0.735 ^A (45)	0.815 ^A (53)	0.612 ^B (33)	0.451 ^C (19)
Coefficient of variation (CV) (%)	17	17	23	25

Numbers followed by different capital letters in the same column or line differ at the 5% probability level ($P < 0.05$).

Approximately 1.052 million birds were assessed.

Minimum least-squared means of arcsine transformed data are presented, with back-transformed means (%) in parentheses.

or 18 consecutive flocks of broilers (Coufal *et al.*, 2006b) showed that disinfection and biosecurity in the production unit is an important part of the success of the broiler rearing enterprise.

Incorrect handling of the litter interfered directly in the appearance of cellulitis, arthritis and contact foot-pad dermatitis. These diseases are an important source of economic loss through downgrading and carcass condemnations, as well as welfare considerations linked to the potential for associated pain and discomfort (Bradshaw *et al.*, 2002; Broom and Reefmann, 2005). Litter microflora are also involved in the presentation of one or all of these three pathologies (Fries *et al.*, 2005).

Management and composting of litter is very important for sanitary conditions, so that the new flock of chickens can be housed safely (Mohee *et al.*, 2008). However, environmental conditions such as humidity and temperature (Jones *et al.*, 2005) are important factors affecting litter microbiological populations. Particle size, capacity for water retention and resistance to trampling (Coufal *et al.*, 2006b) can alter the proliferation of microorganisms in the litter and also physical characteristics, such as compaction. These characteristics can determine the variation in the appearance of cellulitis, arthritis and contact foot-pad dermatitis.

When *Brachiaria* litter was used more than once, the frequency of cellulitis and arthritis increased, with noticeable litter degradation and reduced bird comfort. However, for foot-pad dermatitis, the first use of grass litter demonstrated more abrasive characteristics, but there was no significant change with reuse.

Corncob litter was the worst when the quality of the feet was analysed. The results were poor, with approximately 50% of condemned feet (discarded or reduced value). This reduces the value of the product and industry profits. Haslam *et al.* (2006) determined that the incidence of contact dermatitis may be used

as a welfare assessment measure for broiler chickens and may reflect litter quality and the degree of bird contamination, as well as pain arising from lesions. Other factors can contribute to dermatitis, such as some types of compounds in the litter or faecal material (Mayne *et al.*, 2007). Corncob litter does not offer ideal conditions in terms of physical characteristics.

Sawdust litter, on first use, was normally more lignified, possibly generating small injuries in the skin. Cellulitis resulting from bacterial contamination tends to be reduced in intact skin, with less pain from injuries when there is good management of the litter. Sawdust helps to control moisture, and its use leads to less carcass condemnation. Meluzzi *et al.* (2008a) found that using wood shavings resulted in lower moisture and nitrogen concentrations in the litter, leading to a less foot-pad dermatitis.

For foot-pad dermatitis, the incidence varied between 46% and 25% when sawdust was used as litter. Values were lower than for cut grass and corncob litters. The quality of feet was better than on the other litters. The type and quality of litter is important to diminish food-pad dermatitis, which is more prevalent than other pathologies such as breast burn in the United Kingdom (Haslam *et al.*, 2007). Mayne *et al.* (2007) suggested that litter moisture alone is sufficient to cause food-pad dermatitis in young turkeys. The prevalence of contact dermatitis is an important broiler welfare indicator (Fallavena, 2002; Meluzzi *et al.*, 2008b). In this case, when sawdust was used as the bedding material, foot-pad dermatitis scores did not exceed the threshold of 50 points set by the European Union for stocking densities higher than 30 kg live weight/m².

The index of cellulitis after birds had been kept on rice shell litter was low, perhaps because this litter was composed of smaller and more homogeneous particles. The chickens raised on this litter also showed a low incidence of contact foot-pad dermatitis when compared with the

other substrates studied. The quality of the foot on this litter was the best among the litters analysed. Despite its good capacity for water retention, however, rice shell apparently loses part of its structure after each use.

Cellulitis can have a major effect of the economics of production. Chickens that show this defect cannot be sold as a whole chicken and cannot be used for special cuts due to unacceptable presentation to the consumer (especially products with skin). The most common destination is for use as raw material after removal of the compromised parts, or, if serious, the carcasses will go for industrial use. Losses due to cellulitis occur mostly in the abdominal and thigh regions. In the abattoir where data were collected, condemnations for partial cellulitis represented 2% of the total number of birds slaughtered.

Despite the best result being attributed for sawdust litter, no statistically significant difference was noted between uses. The appearance of cellulitis is linked to factors such as temperature, wind velocity and relative humidity at the litter surface. These affect the rate of cellulitis appearance when comparing farm-management choices (Schrader *et al.*, 2004).

When arthritis is considered, sawdust again showed a more satisfactory result, especially in the last few uses. This reflects the good quality of the material, improving over time.

Contact foot-pad dermatitis also represents significant losses for the industry. Feet with 'calluses' are sold at a much lower price than others. Foot-pad dermatitis can be caused by several factors, the most important being the condition of the litter in the broiler house (Bessei, 2006). Temperatures above 20°C increase the incidence of this disease (Wang *et al.*, 1998). Birds reared on rice shell showed better results for contact food-pad dermatitis. Ground *Brachiaria* litter performed less well than sawdust or rice shell. Significant differences were seen when the litter was reused.

According to Meluzzi *et al.* (2008b), stocking density is not a straightforward indicator of bird welfare; there was no relationship between stocking density and lesion incidence or mortality rate. Our study agreed that the control of environmental conditions, particularly litter quality, appears to be a key issue for broiler welfare. The choice of litter and its subsequent correct management and disinfection, together with the implications this has for the comfort of the birds, is important. Any change that improves welfare and reduces the number of carcass condemnations would bring a significant gain to the industry.

In conclusion, *Brachiaria* grass litter showed the highest incidence of contact foot-pad dermatitis. Corn cob litter also had some negative

effects on foot quality. Broilers raised on rice shell litter demonstrated good results in terms of the incidence of contact foot-pad dermatitis. Considering the general aspects of the different types of litter, the best performance was obtained for birds reared on the sawdust litter. This was shown by the lowest number of partial condemnations because of cellulitis and arthritis, which currently represent the biggest losses for the industry. In addition to its excellent performance related to the incidence of arthritis and cellulitis, foot quality was also good on sawdust litter, with a low percentage of calluses.

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