Airborne Bacteria and Fungi Concentration in Relation with Bedding Type in Broiler Houses

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Abstract:

The aim of this work was the investigation of the effect of bedding type on the airborne concentration of bacteria and fungi in broiler houses. The study was performed in two commercial farms (A and B) with different bedding (chopped straw in farm A, sunflower seed hulls in farm B). The determination of the bacteria and fungi's numbers was performed in the first and the sixth weeks of the production cycle. Both the concentration of the bacteria and fungi showed higher values in the farm A compared with the farm B, especially in the latter period of the production cycle. In both farms, significant differences ($P < 0.05$) were recorded between the two periods of the determinations. The results of this study suggest that using sunflower seed hulls as bedding leads to lower levels of microbial contamination of the air in broiler houses, comparing with the use of chopped straw.

Keywords: airborne bacteria, airborne fungi, bedding materials, broiler houses

Introduction

The results of the existing studies demonstrate that the air inside the broiler houses is contaminated by high concentrations of microorganisms, especially bacteria. The health status of birds and farm workers is affected by the level of airborne microflora (Hartung, 1994; Wathes, 1998). In the same time, high levels of microbiological air pollution pose a huge threat to the natural environment surrounding poultry farms (Seedorf, 2004). Because of this, implementing management practices reducing air pollutants in animal houses represents an urgent requirement.

A few authors have assessed the content of air pollution on broiler farms with regard to the birds' age and productivity (Popescu *et al.*, 2010; Vučemilo *et al.*, 2007; Wójcik *et al.*, 2010). Until, now no study investigated the concentration of airborne microorganisms in relation with the type of bedding in broiler farms. Instead, numerous studies were performed regarding the effect of bedding materials on the health and performance of the broilers (Cengiz *et al.* 2011; Kaukonen *et al.*, 2016; Popescu *et al.*, 2018).

The aim of this work was the investigation of the effect of bedding type (chopped straw vs. sunflower seed hulls) on the airborne

Table 1. Descriptive statistical indicators for mesophilic bacteria and fungi in farms A and B and the significance of the difference in relation with the age of the birds and type of bedding

	Parameter	Age of birds (weeks)	Mean	Standard deviation	Median	Minimum	Maximum
Farm A	Mesophilic bacteria (cfu/m ³)	1	8.84 x 10 ⁵	0.77 x 10 ⁴	8.85 x 10 ⁵	6.75 x 10 ⁵	1.09 x 10 ⁶
		6	4.46 x 10 ⁶	5.14 x 10 ⁵	4.98 x 10 ^{6*}	3.36 x 10 ⁶	8.99 x 10 ⁶
	Fungi (cfu/m ³)	1	1.49 x 10 ³	3.84 x 10 ²	1.52 x 10 ³	7.34 x 10 ²	1.72 x 10 ³
		6	2.64 x 10 ⁴	4.41 x 10 ³	2.65 x 10 ^{4*}	2.05 x 10 ⁴	3.25 x 10 ⁴
Farm B	Mesophilic bacteria (cfu/m ³)	1	8.76 x 10 ⁵	1.25 x 10 ⁵	8.67 x 10 ⁵	7.07 x 10 ⁵	1.03 x 10 ⁶
		6	2.07 x 10 ⁶	2.19 x 10 ⁵	2.09 x 10 ^{6*}	1.70 x 10 ⁶	2.13 x 10 ⁶
	Fungi (cfu/m ³)	1	1.27 x 10 ³	2.74 x 10 ²	1.22 x 10 ³	1.03 x 10 ³	1.62 x 10 ³
		6	2.37 x 10 ⁴	3.34 x 10 ³	2.34 x 10 ^{4*}	1.97 x 10 ⁴	2.81 x 10 ⁴

*P < 0.05 the difference is significant

concentration of bacteria and fungi in broiler houses.

Materials and methods

The research was performed in two commercial broiler farms (farm A and B) in Romania. In both farms, the chickens were raised in similar conditions (ventilation, lighting, heating, feeding and watering) on permanent bedding, chopped straw in farm A, sunflower seed hulls in farm B. In farm A, 64000 chickens were reared in two houses (1680 m²/house), with a density of 39 kg/m² and farm B had 140000 chickens in five houses (1560 m²/house), with 42 kg/m² density. In both farms, the birds were ROSS 308, and they were slaughtered at 40–44 days of age.

The collection of air samples for the determination of the bacteria and fungi's numbers was done with a Merck MAS-100 device in the first and the sixth weeks of the production cycle. The samples were collected in the centre and at both ends of two houses (6 determinations / house) with similar numbers of birds (32000 chickens/house) in each of the farms. Bacteria and fungi were collected in Petri dishes on different standard culture mediums: Columbia agar for mesophilic bacteria and Sabouraud agar for fungi. The air was sampled in a volume of 1 L because preliminary studies show that bacteria and fungi are in great numbers in poultry barns. Plates with the usual bacterial nutrient Columbia agar were then incubated for 24 h at 37°C and those

on Sabouraud agar were incubated for 5 days at 22°C. The grown colonies were calculated by a mechanical optic colony counter, and the results were corrected using the conversion formula devised by Feller (1950). The average number of bacteria and fungi was calculated as colony-forming units in one cubic metre (cfu/m³). All data were analysed with SPSS version 17 software. Descriptive statistical indicators (mean, standard deviation, median, minimum and maximum) of the number of mesophilic bacteria and fungi were calculated. These results were compared between the farms using the Mann-Whitney test. The differences were considered significant if P < 0.05.

Results and discussion

The number of mesophilic bacteria and fungi varied in the investigated farms (Table 1). The determined values are in line with those obtained in other studies that show that in broiler houses, the cultivable concentrations of bioaerosols range from 10⁴ to 10⁷ cfu/m³ for mesophilic bacteria and from 10² to 10⁵ cfu/m³ for fungi (Bakutis *et al.*, 2004; Popescu *et al.*, 2010; Radon *et al.*, 2002; Seedorf *et al.*, 1998; Vučemilo *et al.*, 2007). The concentration of airborne microorganisms in poultry housing reported in literature varies greatly, which could, in part, be explained by different sampling methods used in several studies (Lonc and Plewa, 2010; Vucemilo *et al.*, 2007). The microbial load of the air, in terms of mesophilic bacteria, is influenced by several factors, such as the numbers of sheltered

birds, the breeding technology, the floor type, the bedding materials, the microclimatic conditions, the dust concentration, and the ventilation level (Radon *et al.*, 2002; Wathes, 1998).

In both farms, the total number of mesophilic bacteria exceeded the recommended value (2.50×10^5 cfu/m³, Decun, 1997), 3.5 times in the first week, and in the last period of the production cycle 17.8 times in farm A and 8.3 times in farm B.

Even if the differences between the farms were not statistically significant ($P > 0.05$), yet the numbers of mesophilic bacteria and fungi was higher in farm A than in farm B, especially at the end of the production cycle (Table 1). A higher difference was recorded for mesophilic bacteria in the sixth week, the numbers being double in the farm A compared with the farm B. As regards the fungi, the difference between the farms was lower than for the bacteria (Table 1). Because in both farms the numbers of chicken and the rearing and housing conditions were similar, except for the type of bedding, this difference may be due to the bedding material used. Although both materials are considered adequate in the broiler industry, it is possible that the chopped straw produced more dust than the sunflower seed hulls and it resulted in a higher microbial load of the air. Otherwise, it is recognized that husks make excellent litter because of their large particle size and lack of dust (Miller, 2004). A recent study of Popescu *et al.* (2018) shows that the welfare of the broiler chicken (assessed based on health and environment related indicators) is more appropriate when sunflower seed hulls are used as bedding compared with chopped straw. Probably this result is due also to the lower airborne microbial pollution in those poultry houses using sunflower seed hulls as bedding.

In both farms, the age of the birds influenced significantly the airborne bacteria and fungi concentrations, the microbial air contamination increased simultaneously with the fattening period. This aspect was also shown in other studies (Popescu *et al.*, 2010; Vučemilo *et al.*, 2007).

Conclusion

The results of this study suggest that using sunflower seed hulls as bedding leads to lower levels of microbial contamination of the air in broiler houses, comparing with the use of chopped

straw. Further investigation is needed to establish the extent to which our findings can be generalized.

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