The Effect of Bedding Type on the Welfare Quality of Broiler Chickens

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Abstract
The aim of this study was to investigate the effect of the bedding type on the welfare quality of broiler chicken kept in intensive breeding systems. 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). Except this, the birds were kept in the same conditions in both of the farms. The indicators included in the welfare assessment protocol evaluated relevant aspects of the farm management, housing conditions and the birds' health (plumage cleanliness, locomotion, and lesions of the feet, hocks, and breast). All the indicators within the protocol were assessed by specific methods. The data were processed statistically with the SPSS software. The prevalence of footpad dermatitis and hock burns, and also the number of chicken with locomotion problems and dirty and wet plumage was higher in farm A than in farm B. Although the results of the study indicated major welfare problems in both investigated farms, yet in farm B the welfare of broiler chicken was better than in farm A, probably due to the type of bedding used.

Keywords: welfare assessment, broiler chicken, bedding materials

1. Introduction

Concomitant with the development of the industry of the meat producing chicken, the concern of the researchers, but also of the consumers, for the welfare of the birds became more and more evident in many European countries. The selection for the rapid growth rate determined major changes in the anatomy and physiology of the chicken and led to different welfare problems such as high mortality rates, skeletal and muscular disorders, contact dermatitis, ascites, respiratory and mucous membrane problems, stress, thermal discomfort and behavioral restrictions [1].

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It is generally accepted the fact that the majority of the welfare problems are triggered by genetic and environmental factors and the interactions between these.
The welfare assessment of the meat producing chicken is useful in order to identify the specific problems and to establish the actions for rapid remedial of these.
Several studies were internationally published, regarding the effect of bedding type on the health of meat producing chicken [1-4]. The quality of litter depends on the type of material used, its size and the thickness of the layer [4-6], but also the microclimate level and ventilation, stocking density [7] and broiler nutrition [8]. Some studies demonstrated that straw bedding, compared with wood shavings, appears less advantageous for footpad health in broilers [9, 10]. The properties of the material, such as the roughness of the

particles or water absorbing capacity, might explain the differences between the materials. Bedding material containing smooth and fine particles has been connected with enhanced footpad health, compared with materials with coarse particles [11]. On international level there is no data about the effects of sunflower seed hulls bedding on the health and implicitly welfare of broiler chicken.

The aim of this study was to investigate the effect of the bedding type (sunflower seed hulls vs. chopped straw) on the welfare quality of broiler chicken kept in intensive breeding systems.

2. Materials and methods

The study was performed in two commercial broiler farms in Romania, farm A (comprised of 2 halls, 64000 chicken, 39 kg/m^2 density) and farm B, respectively (with a total of 5 halls, 140000 chicken, 42 kg/m^2 density). In both of the farms the chickens were raised on floor, on permanent bedding (chopped straw in farm A, sunflower seed hulls in farm B). The birds (ROSS 308) in both farms were raised in identical conditions, and they were slaughtered at 40-44 days of age.

The welfare assessment was performed based on some indicators related with the housing conditions, farm management, and the birds' health (plumage cleanliness, locomotion and lesions of the feet, hocks, and breast).

The microclimate quality was assessed by determination of physical parameters (temperature, humidity) and chemical ones (ammonia, carbon dioxide). The measurements were made in the last week of the production cycle, in two consecutive days, in three different places in each hall (6 determinations/hall). At the end the mean value was calculated for each parameter. Ammonia concentration was determined by air sampling with a Dräger – Multiwarn II (Dräger Safety, Germany) device. Air temperature and relative humidity were measured with a Testo 400 (GmbH & Co) device.

The assessment of contact dermatitis was made by clinical exam in each hall of both of the farms of 100 chickens, assessing the lesions on their footpads, hocks and breasts. The percentage of the affected chickens in the hall was extrapolated to the number of the birds in the given hall in the moment of the examination. In the same way the locomotion and plumage cleanliness were assessed. These indicators were assessed using the methods described in the Welfare Quality protocol [12].

The obtained data were statistically processed with the SPSS version 17 software. Descriptive statistical indicators (mean, standard deviation, median, minimum and maximum) of the measurements were calculated. The comparison of the results was made with the Mann-Whitney test. The differences were considered significant if $p < 0.05$.

3. Results and discussion

The values of the descriptive statistical indicators (mean, standard deviation, minimum, maximum and median) for the microclimate parameters (physical and chemical) determined in each hall of the farm A are shown in table 1. All the physical and chemical indicators of the microclimate in both of the farms exceeded the maximal admitted values.

The temperature, relative humidity, airborne ammonia and carbon dioxide concentrations were in the admitted limits in two of the five halls (H2 and H5) in farm B (Table 2).

Table 1. Descriptive statistical indicators for the physical and chemical parameters of the microclimate in farm A (hall 1 and 2)

	Parameter	Mean	Standard deviation	Median	Minimum	Maximum
Hall 1	Temperature (C°)	24.75	0.58	24.85	24.00	25.60
	Relative humidity (%)	74.35	3.28	74.80	69.00	78.00
	Ammonia (ppm)	26.50	3.51	28.00	20.00	29.00
	Carbon dioxide (ppm)	2550.00	546.81	2700.00	1800.00	3100.00
Hall 2	Temperature (C°)	25.20	0.52	25.10	24.60	26.00
	Relative humidity (%)	80.82	2.13	80.75	78.00	84.00
	Ammonia (ppm)	29.67	2.58	30.50	26.00	32.00
	Carbon dioxide (ppm)	2483.33	746.77	2650.00	1500.00	3400.00

Table 2. Descriptive statistical indicators for the physical and chemical parameters of the microclimate in farm B (halls 1-5)

	Parameter	Mean	Standard deviation	Median	Minimum	Maximum
Hall 1	Temperature (C°)	21.85	0.54	22.00	21.00	22.60
	Relative humidity (%)	73.23	0.97	73.70	72.00	74.00
	Ammonia (ppm)	20.83	1.47	20.50	19.00	23.00
	Carbon dioxide (ppm)	3358.33	156.26	3400.00	3100.00	3500.00
Hall 2	Temperature (C°)	18.42	0.38	18.45	18.00	19.00
	Relative humidity (%)	68.57	1.02	68.70	67.00	70.00
	Ammonia (ppm)	18.00	1.79	18.50	15.00	20.00
	Carbon dioxide (ppm)	1900.00	89.44	1900.00	1800.00	2000.00
Hall 3	Temperature (C°)	24.10	0.69	24.10	23.00	25.00
	Relative humidity (%)	78.50	2.17	78.00	76.00	82.00
	Ammonia (ppm)	24.00	3.40	24.50	20.00	28.00
	Carbon dioxide (ppm)	3416.67	147.19	3450.00	3200.00	3600.00
Hall 4	Temperature (C°)	23.97	1.06	24.00	22.00	25.00
	Relative humidity (%)	79.77	3.78	78.80	76.00	87.00
	Ammonia (ppm)	37.33	1.63	37.50	35.00	39.00
	Carbon dioxide (ppm)	3750.00	77.46	3775.00	3600.00	3800.00
Hall 5	Temperature (C°)	19.30	1.01	19.90	18.00	20.00
	Relative humidity (%)	69.00	2.00	70.00	65.00	70.00
	Ammonia (ppm)	18.83	1.17	19.00	17.00	20.00
	Carbon dioxide (ppm)	1875.00	117.26	1875.00	1700.00	2000.00

The deviations of the microclimate factors (physical, chemical and biological) from the admitted values have negative repercussions not only on the welfare of the broiler chicken but also on their meat quality. The researches made highlight the need to maintain a good air quality in the broiler raising halls during all their growth, being an essential condition for an acceptable level of the birds' welfare.

The temperature and relative humidity influences the thermal comfort of the birds and for this the recommended level has to be maintained (temperatures between 26 and 32 C° in the first period and later between 16 and 20 C°, relative humidity 70%). At older ages of the chicken increased relative humidity leads to wetting of the litter and consecutively to impaired footpad health [13]. The increased humidity, associated with the increase of the temperature, as this study recorded, produce discomfort for the chicken, because the combined effect of these two physical factors of the microclimate [14, 15]. The temperature and relative humidity of the air, but also other factors of the microclimate are influenced by the density of the chicken and the ventilation system's efficiency. In a study it was found that the percentage of birds that died on the entire duration of the growing period was positively correlated with the temperature and relative humidity between the weeks 3 to 5 [16]. The conclusion of this study was that the housing conditions (bedding quality, the temperature and humidity of the air) were more important for the welfare of the chicken than the density of animals.

The concentration of airborne ammonia was much higher than the admitted limit in both of the investigated farms. High concentrations of this gas have negative impact on weight gain, food conversion and immune function of the birds [17]. Different studies made in broiler halls show that airborne ammonia concentrations of 10 ppm or more can affect the respiratory function and increase the susceptibility to breathing system diseases, especially to the infections with E. coli [18]. Olanrewaju et al. [19], in a study concluded that airborne concentrations of 25 and 50 ppm of ammonia produced eye lesions in 7 days after the initial exposure. Based on his research, Owada [20] suggested that 5 ppm should be the maximum airborne level of ammonia for meat producing chicken. In the broiler farms the most important factors that influence the ammonia production in the air are air temperature, ventilation rate, humidity, and food composition, bedding pH, the bedding humidity, bedding type and the density and age of birds [21].

In the investigated farms the concentration of carbon dioxide exceeded 3000 ppm, which is the

maximal admitted limit in the halls of birds. Generally, the carbon dioxide level's increase does not produce alone any prejudice for the animals, but indicate the increase of other, more toxic, air pollutants' concentration.

The prevalence of contact dermatitis in the A and B farms is shown in Table 3. A significantly ($p < 0.05$) higher prevalence of footpad lesions was recorded in farm A, comparing with the farm B. Even if the prevalence of hock lesions was higher too in farm A, the difference was not statistically significant ($p > 0.05$). The prevalence of contact dermatitis was lower that reported by different researchers for broiler chicken in intensive rearing systems [22, 23, 24]. Contact dermatitis is a common problem, causing impaired welfare of broilers [10, 25]. Different studies showed that, both footpad lesions and those of the hocks are induced on wet litter and mostly in the conditions of increased airborne ammonia concentrations [1, 3]. Based on the existing evidences, it is reasonable to speculate that the physical factors have influence on the development of feet lesions. It is known that the lesions that have such origins can be exacerbated by external irritants, including humidity, thus it is possible that the environmental and physical factors to work in synergy to promote the development of the lesions. Higher incidence of footpad dermatitis was reported by Hashimoto et al. [26] in a study performed in 45 commercial Japanese farms. In 3 farms all the examined birds had lesions. In the other 42 farms the incidence of footpad dermatitis varied between 31.9% and 99.5%.

The influence of bedding type and quality on the prevalence of contact dermatitis was studied by different researchers [1, 2, 3, 4]. This aspect was noted in our study too. The birds in farm A, kept on permanent litter of chopped straw had a higher percentage of contact dermatitis, both in their footpads and their hocks. This situation is produced due to the use of a too thick layer of bedding, that lead to insufficient aeration and drying of the litter, both because of the instinct of scratching of the chicken and the inefficiency of ventilation. The higher humidity in this farm contributes significantly to the poor quality of the bedding. Cengiz et al. [27] observed a significant increase of footpad dermatitis' incidence in broilers as the humidity of their bedding increases. The reduced dimensions of the bedding particles and the overall better litter quality were associated with the decrease of footpad dermatitis. In another study investigating the potential risk factors for the poor welfare in broilers it was noted that as the litter quality worsened, the number of birds suffering by footpad dermatitis increased by 12.9% [2].

Similarly, with the results communicated by Federici et al. [24], no breast dermatitis was identified in our study.

Other factors were incriminated too in the development of contact dermatitis in broilers. Ventura et al. [28] observed a positive linear relationship between the severity of feet lesions and the density of the birds. In another study it was reported that the numbers of ulcerative lesions of the birds lowered as the lighting intensity increased [29].

Thus, the main concern of the farmers should be the maintenance of an optimal microclimate in the broiler farms for a reduced incidence of contact dermatitis. Also, the balanced genetic selection can be an efficient strategy to reduce the genetic predisposition for contact dermatitis development in broiler chickens [30].

In both the investigated farms locomotion problems were observed in the chicken (Table 4). The prevalence of lameness (score 4 and 5) was slightly higher in farm A than the prevalence observed by Knowles et al. [31] and Souza et al. [32] in their studies and lower than that reported by Federici et al. [24]. The influence of rapid growth can be considered as the main factor for locomotion problems [25]. Except the inability to walk, there are proofs that this severe problem is associated with pain [33].

Table 4. The prevalence of some welfare indicators in the two assessed farms

Indicator	Farm A	Farm B
Plumage dirtiness (%)	85	60
Lameness (% of scores 4 and 5)	9.2	7.5
On farm mortality (%)	3.62	2.8

Table 3. Prevalence of contact dermatitis in the A and B farms

	Farm A		Farm B				
	Hall 1	Hall 2	Hall 1	Hall 2	Hall 3	Hall 4	Hall 5
Footpad lesions	20	30	16	14	22	20	12
Hock lesions	8	12	6	2	10	6	4
Breast lesions	0	0	0	0	0	0	0

Air quality and temperature directly affect leg health. Poor control of broiler house temperature has been associated with impaired walking ability [13], while wet litter [16] and higher ammonia levels have been linked to valgus deformity [13, 16].

Regarding the plumage aspect, in the A farm a higher number of chickens were found with dirty and wet plumage, as a consequence of more severe microclimate noncompliance comparing with farm B (table 4). It seems that a positive correlation exists between the bedding quality and the cleanliness of the birds' plumage, thus the clean plumage can indicate the bedding quality [24]. This aspect was observed in our study too.

In the investigated farms mortality was of 2.8% in farm B and 3.62% in farm A, being in accordance with the results obtained in other studies [24]. Both farms accept a mortality rate of 2% per production cycle, as technological lost. In an extended study in the British, Belgian and Italian farms, the mean mortality for fast growing chicken was of 2.9% and the mean mortality for the alternative breeds, with slower growth was of 3.1% [34]. In another study in Dutch fast-growing broilers, the mean mortality was of 2.88% [22]. Dawkins et al. [16] reported different mortality levels from 1.4 to 14.7% in commercial farms, and their study density varied from 30 to 46 kg/m^2. Interestingly, the density of the birds did not affect significantly their mortality, but the farm environment was the factor with the highest impact on mortality. Kalmar et al. [35] suggest that the sudden death syndrome, ascites, foot problems and contact dermatitis, in addition to fast growing rate, are the main causes of mortality in production systems for broiler chicken.

4. Conclusions

Although the results of the study indicated major welfare problems in both investigated farms, yet in farm B the welfare of broiler chicken was better than in farm A, probably due to the type of bedding used.

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