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EFFECTS OF LIGHT INTENSITY IN DIFFERENT STOCKING DENSITIES ON TIBIAL MEASUREMENTS AND INCIDENCE OF LESIONS IN BROILERS

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Original scientific paper

Abstract: The possibility for use of high light intensity in broiler production management to improve the health of broilers' legs was examined in a study aiming to determine the effect of two levels of light intensity in different stocking densities of broiler chickens. The study was carried out on 1200 Ross 308 broilers according to a random block system with 6 treatments (2 x 3 factorial design) and 4 replicates per treatment. The examined light intensity levels of 150 lx (high light intensity-HLI) and 20 lx (low light intensity-LLI) were applied to 3 stocking densities of broilers: 10, 13 and 15 birds/m^2. Scoring of foot pad (FP) and hock burns (HB) was carried out on the 42nd day, on a sample of 240 broilers. Osteometric and biomechanical measurements on tibia were performed after slaughtering and primary processing, on a sample of 72 broilers. The high level intensity of light exerted no significant effect on the development and firmness of the tibia of broilers grown in the densities of 10, 13 and 15 birds/m^2. There are indications that in the highest studied stocking density the increased light intensity can improve the individual properties of tibia. The differences in the average assessment of hock burns were concluded to be the result of the stocking density that was observed only in conditions of the increased intensity of light. The average score of foot pad lesions was under the significant main effect of both investigated factors. The differences in the average FP estimation between the light intensity treatments were confirmed in the stocking density of 13 birds/m^2.

Key words: broiler, light intensity, stocking density, tibia, lesions

Introduction

The recommended conditions regarding the light intensity in broiler production lead to the fact that broilers often spend time in the half-dark, without clearly differentiated periods of light and darkness. Such conditions may influence the establishment of circadian rhythms responsible for the processes of bone mineralization, physical activity of broilers, and eventually, health of the legs.

The light of increased intensity stimulates daily activity, as confirmed by *Blatcherford et al. (2009)* who state that the light intensity of minimum 50 lx has positively influenced daily activity without adverse effects on production performances.

With high level intensity of light, behaviour patterns are more prominent and broilers are more physically active (*Blatcherford et al., 2012; Rault et al., 2017).* Expressed physical activity can be accompanied by weight reduction *(Lien et al., 2008; Blatcherford et al., 2012; Rault et al., 2017),* which can create conditions for the reduction of leg problems. *Škrbić et al. (2011)* have established the presence of indications that higher physical activity in conditions of lower stocking density of broilers, improves the quality of tibia, even with higher final weight of broilers. In support of this are the results of *Kapell et al. (2012)* on the established genetic correlation between the health properties of legs and the broiler weight that is low to moderately negative, which leaves the possibility of improving these properties by breeding methods. The low light intensity does not sufficiently stimulate broiler activity, according to *Rault et al. (2017),* although there was no clear evidence of adverse effects on the broiler welfare and the strength of the leg. Differences in gait scores were not recorded in *Blatcherford et al. (2009),* but broilers in treatment with 200 lx had less lesions compared to treatments with 5 and 50 lx. *Deep et al. (2010)* came to similar results in their examination of light intensity levels of 1, 10, 20 and 40 lx that did not show the effect on leg health, estimated on the basis of a gait score, while the incidence of ulcerous foot pad lesions decreased linearly with the increase in light intensity. In the later study by *Blatcherford et al. (2012)* they have confirmed the effect of light intensity on the health of broilers in terms of less incidence of lameness in higher intensity of light. In this regard, it is possible to note certain potential of using increased light intensity in the management of broiler production to improve the health and welfare of broilers, with the necessity of more precise determination of optimal levels in accordance with technological conditions and genotype.

The aim of the study was to determine the effect of two levels of light intensity in different stocking densities of broiler chickens, and thus examine their interactive effect on foot health indicators, that is, the strength of the tibia and the appearance of foot pad and hock burns lesions.

Material and methods

A total of 1200 Ross 308 one-day broilers were placed in the floor pens in a random block system with 6 treatments (2 x 3 factors design) and 4 replicates per treatment. The examined light intensity levels of 150 lx (high light intensity- HLI) and 20 lx (low light intensity-LLI) were applied to 3 stocking densities of broilers: 10, 13 and 15 birds/m^2. The duration of the photo period was 18 hours. The light source was incandescent bulbs of adequate intensity, according to the trial design. The control of the light intensity was performed at the level of broiler eyes in 3 positions, at right angle *(Lewis and Morris, 2006).* A four-phase program of nutrition on corn/soy based mixtures was applied. The bedding/litter was from chopped straw. Scoring foot pad (FP) and hock burns (HB) was performed at the end of the trial, on 42nd day, with a three-step scale *(Thomas et al., 2004):* no lesions (score 1), moderate lesions (score 2), severe lesions score 3). Investigation of the incidence and severity of the lesions was carried out on a sample of 240 broilers, i.e. 40 broilers per treatment with equal sex ratio in the sample. Tibia was measured on a sample of 72 broilers (12 broilers per treatment with equal sex ratio) after the examination of the slaughtering quality of the carcass *(Škrbić et al., 2018)* and the separation of other tissues from the bone. The bone weight and the length of the proximal to distal end of the bone were measured. Diaphysis cross-sectional area was calculated on the basis of measured anterior posterior and lateral medial diameter *(Vitorović et al., 1992).* Bone firmness was determined using a direct method of three-point-bending test, with a support width of 40 mm, using the IPNIS apparatus *(Mašić et al., 1985).* The specific breaking force was calculated as the ratio of the breaking force and the surface of the cross-section of the tibia diaphysis.

Data analysis was performed by the factorial ANOVA software package STATISTICA, version 8, StatSoft, Inc(www.statsoft.com). The mean values were tested with the Tukey test at the significance level $p < 0.05$.

Results and discussion

The morphometric parameters of the tibia of broilers grown in the conditions of 150 lx and 20 lx intensity of light in stocking densities of 10, 13 and 15 birds/m^2 are shown graphically (Figure 1).

The weight, length and surface area of the cross-section of the tibia diaphysis were not significantly affected by the factors examined. The measured weight of tibia of broilers grown in densities of 10 and 13 birds/m^2 was lower in HLI compared to LLI. On the contrary, broilers reared in a density of 15 birds/m^2 had slightly heavier tibia under conditions of higher intensity compared to lower

intensity of light. The length of the tibia was lower in all three stocking densities under conditions of high light intensity. It is noticeable that the difference between the average values of the length of the bone, as a light intensity effect, decreased with increasing stocking density. The effect of the high light intensity on the development of tibia, based on the calculated cross-section, is mostly expressed in conditions of stocking density of 15 birds/m^2.

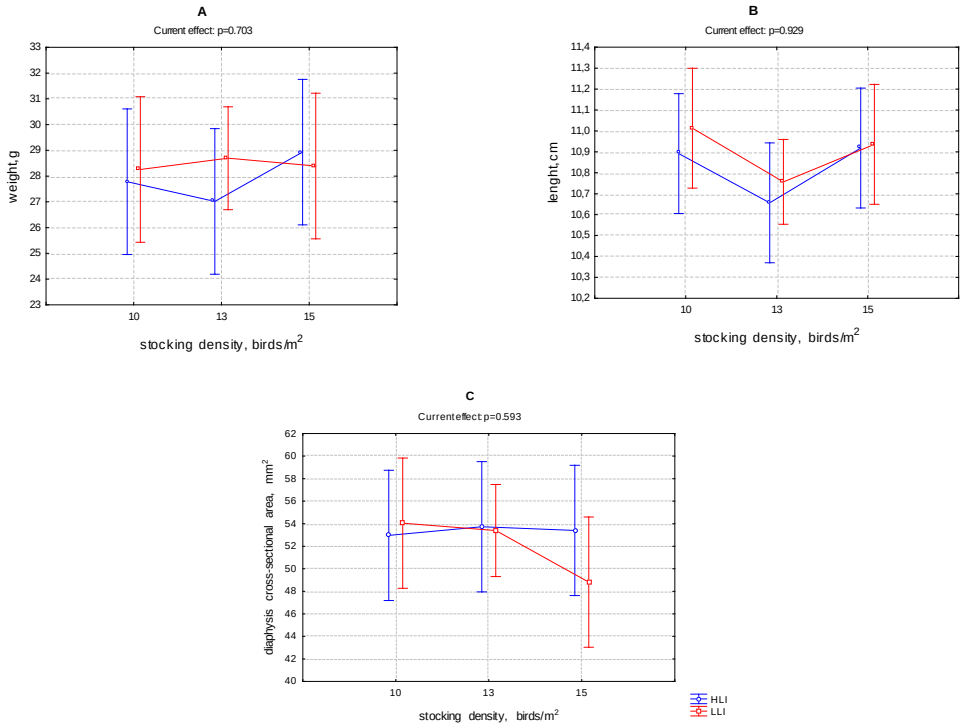

Figure 1. Morphometric parameteres of tibiotarsus broilers in various conditions light intensity and stocking density; A-weight B-lenght C-diaphysis cross sectional area

Biomechanical parameters of the quality of tibiotarsus are shown in Figure 2.

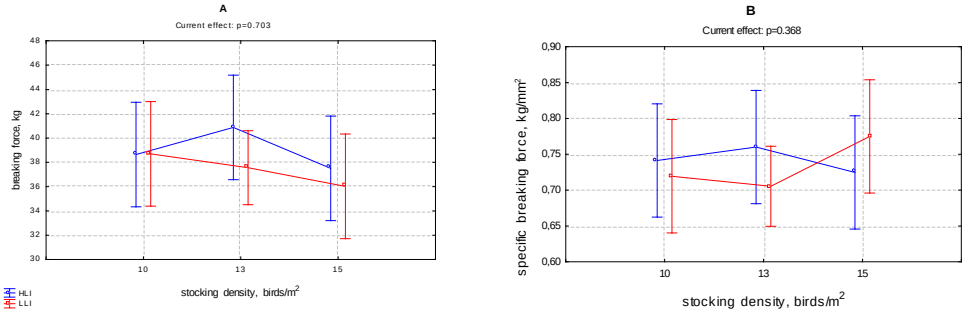

Figure 2. Biomechanical parameters of tibiotarsus broilers in various conditions light intensity and stocking density; A-breaking force B-specific breaking force

The firmness of the tibia expressed by breaking force was the highest in HLI treatment and the density of 13 birds/m^2. In conditions of lower intensity of light, the breaking force linearly decreased with increasing stocking density. The exposure of broilers to the light of increased intensity has led to a change in the indicated tendency, however without the statistical confirmation of the obtained results. As a result of lower breaking force and greater cross-sectional area of the tibia diaphysis in HLI treatment and 15 birds/m^2 density, a lower specific breaking force was calculated in relation to HLI treatments and a density of 10 and 13 birds/m^2.

Broilers of commercial genotypes show more locomotor problems and FP lesions compared to autochthonous breeds and therefore poorer foot health *(Alves et al., 2016)*, which is associated with a rapid early increase and lower broiler activity *(Angel, 2007; Knowles et al., 2008)*. The stocking density directly, through the available space for movement, affects the activity of broilers, and in this respect, the ability to move through the gait score *(Škrbić et al., 2009)*. Results of *Škrbić et al. (2011)* point to the improvement of the measured absolute values of the quality parameters of tibia as a result of broiler activity in the lower stocking density. The high stocking density of broilers changes the intestinal absorption and the metabolism of calcium and phosphorus associated with the quality of tibia *(Sun et al., 2018)*. The effect of the investigated light intensities in the stocking density of 10, 13 and 15 birds/m^2 on morphometric and biomechanical parameters of tibia was absent in this study. However, there are indications that in conditions of higher stocking density, in which there are poorer conditions for movement, high light intensity stimulates the activity of broilers and improves the individual properties of tibia compared to the same lighting conditions in lower stocking density. In our research, generally low stocking density did not cause great differences in the housing conditions and environment between treatments, which may be the reason for the insufficient differences between treatments. In support of this, *Sherlock et*

al. (2010) show that in the semi-intensive conditions of growing gradual changes in the intensity of light did not affect the activity of broilers.

The average scores and incidence of foot pad lesions estimated according to severity of damage in light intensity and stocking density are shown in Table 1.

Table 1. The effect of the light intensity in different broiler stocking densities on the foot pad score (frequency and average assessment)

Light intensity / Stocking density	LLI			HLI			P		
	10	13	15	10	13	15	Light intensity	Stocking density	Interaction
Foot pad %									
1	41.67	25.00	0	75.00	58.33	0			
2	25.00	16.67	0	25.00	33.33	8.33			
3	33.33	58.33	100	0	8.34	91.67			
Average score	$1.92^{ab} \pm 0.90$	$2.33^{bc} \pm 0.89$	$3.00^{c} \pm 0.00$	$1.25^{a} \pm 0.45$	$1.50^{a} \pm 0.67$	$2.92^{c} \pm 0.29$	0.000	0.000	0.099

The average FP scores were significantly affected by the intensity of light and stocking density, while the interaction of these two factors was not statistically confirmed. A better average FP score was found in broilers housed in conditions of higher intensity of light, and this difference was statistically confirmed only in the density of 13 birds/m^2, where average scores of FP lesions were 2.33 in LLI treatment and 1.5 in HLI. The greater prevalence of FP dermatitis in treatment with 5 lx versus 20 lx, is stated by *Rault et al. (2017)* and explained by the lower activity of broilers and, consequently, by the greater susceptibility of broilers that are still to the incidence of contact dermatitis. However, in light intensity conditions 0.5; 5 and 10 lx, *Olanrewaju et al. (2015)* have not found differences in the incidence of FP dermatitis. By examining the predisposing factors for the development of FP lesions in broiler flocks in Denmark, *Kyvsgaard et al. (2013)* have found a smaller main effect of the stocking density on the development of FP lesions compared to interaction with the season. Since moisture levels are the primary cause of contact dermatitis *(de Jong et al., 2014),* in conditions of high humidity of litter, the effects of the examined treatment on FP dermatitis are lost *(Fidan et al., 2017).* In this way, the inconsistency of the results of the effects of certain factors on the occurrence of FP lesions can be explained.

The effect of HLI and LLI in the tested stocking densities of broilers on the average score and frequency of incidence of hock burns estimated according to the severity of the damage are shown in Table 2.

Table 2. The effect of the light intensity in different broiler stocking densities on the hock burn score (frequency and average assessment)

Light intensity Stocking density	LLI			HLI			P		
	10	13	15	10	13	15	Light intensity	Stocking density	Interaction
Hock burns %									
1	66.67	58.33	33.33	100	75.00	8.33			
2	25.00	8.33	33.33	0	8.33	41.67			
3	8.33	33.33	33.33	0	16.67	50.00			
Average score	1.42^{ab} ± 0.67	1.75^{abc} ± 0.97	2.00^{bc} ± 0.85	1.00^{a} ± 0.00	1.42^{ab} ± 0.79	2.42^{c} ± 0.67	0.520	0.000	0.100

There were no significant differences in the average HB score between the investigated levels of light intensity. The effect of the light of increased intensity did not lead to significant differences in the average HB scores observed by groups of broilers of the same stocking density. Starting from the absence of a significant effect of the intensity of light on the firmness of the broiler tibiotarsus, the incidence and severity of hock burns can be considered expected. In support of this, *Kristensen et al. (2006)* in which they confirm a positive correlation between the gait score, the indicators of the leg problems, and the hock burns. Because of the lameness of broilers, the incidence of hock burns is higher. The established differences in the HB score are the result of the effect of the stocking density. However, we must conclude that the difference between groups of different stocking density is determined only in conditions of increased light intensity.

Conclusion

The light of increased intensity showed no significant effect on the development and firmness of the tibia of broilers grown in the stocking densities of 10, 13 and 15 birds/m^2. There are indications that in the highest stocking density, the light of increased intensity can improve the individual properties of tibia.

The differences in the average scores for hock burns were determined as the result of the stocking density observed only in conditions of a high light intensity.

The average score for foot pad lesions was under significant main effect of both investigated factors. The differences in the average FP scores between the light intensity treatments was confirmed in the stocking density of 13 birds/m^2.

In general, the results of the study indicate that the high light intensity may influence increase in the tibia firmness and reduce the incidence of contact lesions,

or alleviate the adverse effect of stocking density on foot health, with the need for further research in conditions of higher stocking density.

Efekti intenziteta svetlosti u različitim gustinama naseljenosti na parametre tibije i pojavu lezija kod brojlera

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Rezime

Mogućnost upotrebe svetlosti jačeg intenziteta u menadžmentu brojlerske proizvodnje za poboljšanje zdravlja nogu brojlera, ispitana je u ogledu sa ciljem utvrđivanja efekta dva nivoa intenziteta svetlosti u različitim gustinama naseljenosti brojlerskih pilića. Istraživanje je sprovedeno na 1200 Ross 308 brojlera po slučajnom blok sistemu sa 6 tretmana (2 x 3 faktorijalni ogled) i 4 ponavljanja. Ispitivani nivoi intenziteta svetlosti 150 lx (HLI) i 20 lx (LLI) su primenjeni u 3 gustine naseljenosti brojlera: 10, 13 i 15 birds/m^2. Procena lezija na tabanskom jastučiću (FP) i skočnom zglobu (HB) je izvršena 42. dana, na uzorku od 240 brojlera. Osteometrijska i biomehanička merenja na tibiji su izvršena nakon klanja i obrade, na uzorku od 72 brojlera. Svetlost jačeg intenziteta nije uslovila signifikantan efekat na razvoj i čvrstoću tibije brojlera gajenih u gustinama naseljenosti 10, 13 i 15 grla/m^2. Postoje indicije da u najvećoj ispitivanoj gustini naseljenosti, svetlost jačeg intenziteta može poboljšati pojedine osobine tibije. Razlike u prosečnoj oceni HB utvrđene su kao rezultat efekta gustine naseljenosti koji je ispoljen samo u uslovima jačeg intenziteta svetlosti. Prosečna ocena FP lezija je bila pod značajnim glavnim (main) efektom oba ispitivana faktora. Razlike u prosečnoj oceni FP između tretmana intenziteta svetlosti potvrđene su u gustini naseljenosti 13 grla/m^2.

Ključne reči: brojler, intenzitet svetlosti, gustina naseljenosti, tibija, lezije

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