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Full Length Research Paper

The effect of rearing conditions on carcass slaughter quality of broilers from intensive production

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Requirements for improvement of broiler welfare have initiated certain changes in rearing and management conditions in conventional broiler production, with emphasis on stocking density and duration of photo period. Experimental study was conducted on broilers of fast growing genotypes reared in floor system. Two stocking densities were applied: 12 and 16 birds/m^2 and two light regimes: continuous: 23 h light (23 L):1 h dark (1 D) and intermittent: 4 h light (4 L): 2 h dark (2D), with 4 repetitions per treatment. Growth dynamics was investigated on 800 broilers and carcass quality traits (carcass weight, conformation, yields of major carcass parts and tibia quality) on sample of 80 carcasses differentiated according to gender of chickens. More intensive growth of broiler in the group reared in lower stocking density, that is, intermittent light regime, was established. Broilers reared in lower stocking density had significantly better carcass conformation and higher yield of breast, whereas in the response to the light regime the effect of sex was determined. Because of more physical activity of broilers in lower stocking density, the parameters of tibia quality are improved. In regard to present measures for preservation and improvement of animal welfare, application of lower stocking density of broilers and intermittent light regime is justified also from the aspect of improvement of carcass quality.

Key words: Broilers, stocking density, light regime, carcass quality.

INTRODUCTION

Conventional system of production of poultry meat, based on high growth rate and efficient use of feed of broiler hybrids housed in high stocking density, in closed facilities with artificial light and air ventilation, is subject to constant criticism. In general, interest for the quality of poultry meat is considerably increasing compared with the quantitative aspect of this production. Despite the relatively low price of poultry meat deriving from intensive production, consumers have realized the importance of products from non-industrial systems which ensure not only welfare conditions for chickens, but also provide high nutritional level and bio-safety of the product. At the same time, such production systems (free-range, organic) have strictly defined standards, country specific, which relate to chicken genotype, use of pasture (range), maximum stocking density, age of birds at slaughtering, nutrition, which eventually limits the production volume and provides the possibility to satisfy the needs of particular part of the market.

Consumer awareness of animal welfare and associated changes in the perception of the quality of the product (Sundrum, 2001) and regulations, European (Council Directive 2007/43/EC) and national require certain changes in conditions and management of broiler production which among other things, relate to stocking density and duration of photo period.

Numerous researches carried out in order to determine the optimum stocking density in intensive broiler production from the aspect of production performance and carcass quality (Lewis et al., 1997; Edriss et al., 2003; Mendes et al., 2002; Dozier et al., 2005) but also stress indicators (Dozier et al., 2006; Thaxton et al., 2006;

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Abbreviations: SD, stocking density; **LR,** light regime; **L,** light; **D,** dark.

Ozbey and Esen, 2007), indicate the growing importance of this factor. The effect of stocking density on growth rate is direct and associated with the possibility of undisturbed emission of heat generated in the process of nutrient metabolism (Yadgari et al., 2006). Heat sensitivity increases in higher stocking density due to increase in temperature of the litter and limited air circulation around chickens. In addition to this direct impact, stocking density also indirectly influences the microclimate in the facility (ammonia production, litter humidity) and forming of other environment factors of importance for demonstration of high genetic potential of broilers.

Continuous light regimes such as 24 L or 23 L:1D have been a norm in the poultry production for a long time, based on fact that, chickens consume feed only during photo period, so in this way optimal growth intensity was ensured, that is, digestion and absorption of nutrients. However, because of welfare indicators, application of continuous light regimes has been reduced, but it still cannot be established with certain level of reliability which is the optimal duration of photo period within 24 h. In Denmark, according to Petersen (2004), broilers must have at least 8 h of dark during 24 h, although, it is anticipated that this period of dark will be reduced to 3 h. In Serbia, according to current Rulebook on Animal Welfare Conditions (2010) fattening chickens, after 7 days, must have minimum of 6 h of darkness during 24 h period, with continuous 4 h dark period. Previous researches were focused on application of different types of light regimes, restrictive, discontinuous, with prolonged photo period and their effect on production parameters and incidence of skeletal diseases (Buyse et al., 1996; Gordon, 1999; Sanotra et al., 2002; Guler and Yalcin, 2004). Only few studies focused on carcass quality traits under the influence of light regimes (Renden et al., 1996; Lien et al., 2007).

The objective of this study was to determine the effect of changes in the rearing conditions in intensive broiler production relating to two important factors of the environment; stocking density and light regime, on quality of carcass from the aspect of growth of broilers and carcass weight, body development (carcass conformation), yield of major carcass parts and quality of tibia, as indicator of the quality of tubular bones. Expected positive effects of the optimization of the environment conditions would enable compromise between quantitative and qualitative aspect of intensive production.

MATERIALS AND METHODS

Trial was carried out in two phases. In the first phase, increase of body weight was investigated on sample of 800 individually identified broilers, whereas in the second phase of trial, study of the carcass and right tibia collected from random sample of 80 broilers (20 per treatment) and differentiated according to gender was carried out. Trial was designed as two factor trial; stocking density x light regime (2 x 2), with 4 repetitions of each treatment.

One day old chickens of fast growing genotype were housed in pens with deep litter in two densities (SD): 12 birds/m^2 (SD_1) and 16 birds/m^2 (SD_2) of floor surface, until 42 days of age. All chickens had adequate feeding and watering space. In this way, the impact of other factors which could diminish the demonstration of the effect of studied treatments was excluded. Two light regimes were applied (LR): continuous (C) and intermittent (I) which differed in duration of photo period. Continuous light regime was 23 L:1D. Intermittent light regime implied cyclic rotation of 4 L:2D, that is, total duration of photo period of 16 h. Application of intermittent light regime started at the age of 8 days, due to insufficiently functionality of the system of heat regulation in the first days of their life, as well as climatic conditions at the time the trial was carried out. In order to determine the dynamics of growth of fattening broilers, control recording of body weight was done in weekly intervals by individual weighing of identified chickens. Based on obtained data, average daily weight gain was calculated for each week of the study.

After slaughtering and initial treatment of the selected sample, the following measures were taken on cold carcasses; shank length (SL), keel length (KL), breast depth (BD), breast angle (BA) and thigh girth (TG), according to method by Pavlovski and Masic (1983), which indicate the body structure and development of certain, major carcass parts. In order to eliminate the influence of body weight on measures, their index values are presented (BW/SL, BW/KL, BW/BD and BW/TG) with the exception of breast angle which represents genetically determined trait and as such, is under small influence of body weight.

Cutting of carcasses and separation of major carcass parts; breast, thigh and drumstick, was done according to Commission Regulation (EC) no 543/2008. Subsequent to determination of their weight, yield in relation to pre-slaughter body weight were determined.

Physical properties, that is, metric and mechanical investigations on tibia were done individually on right tibia after its removal from the broiler skeleton. Surface of the cross section of the bone diaphysis was determined based on measured values for anterior-posterior (R_1) and lateral-medial (R_2) tibia diameter according to formula for calculation of the surface of ellipse (Vitorovic, 1992). Bone firmness was invested by direct method (Masic et al., 1985) based on breaking force measured on apparatus IPNIS, the width of the support of 40 mm. Specific breaking force of bones as a relative indicator of the bone firmness was calculated based on the ratio between breaking force and surface of the cross section of the tibia diaphysis (Breaking force, kg/ cross surface, mm^2).

Obtained data bases were analyzed using computer program Stat. Soft, Inc. (2003) STATISTICA (data analysis software system), version 6, according to mathematical model:

$$Y_{ijk} = \mu + SD_i + LR_j + (SD \times LR)_{ij} + e_{ijk}$$

That is, in a two-factor design of 2x2 (2 stocking densities - SD, 2 light regimes –LR). All significant differences established based on variance analysis were evaluated using Tukey test.

RESULTS

Research results presented in Table 1 indicate positive main effects of the intermittent light regime and lower stocking density on increase of body weight of broilers. Differences in average daily gain between groups with continuous and intermittent light regimes were significant in the 3rd week of age ($p < 0.05$) and in the 6th week of age ($p < 0.01$). Also, positive effect of lower stocking density was the highest at the end of the fattening period, although, statistically significant differences were confirmed

Table 1. Daily gain (g) of broilers in weekly intervals.

Treatment	Daily gain (g) (Mean ± SD)					
	Age (weeks)					
	1	2	3	4	5	6
C		33.8 ± 4.6	52.8 ± 8.2	63.3 ± 13.1	63.9 ± 15.8	64.8 ± 27.1
I		33.8 ± 5.2	54.0 ± 8.5	64.3 ± 14.6	65.3 ± 16.4	75.5 ± 18.7
SD_1	15.7 ± 2.3	35.1 ± 4.8	54.0 ± 7.9	67.6± 12.5	63.7 ± 17.0	80.5 ± 15.2
SD_2	14.9 ± 2.8	32.8 ± 4.6	53.0 ± 8.7	61.0 ± 14.1	61.3 ± 15.4	62.5 ± 26.2
C x SD_1		34.8^{a} ± 4.7	53.0^{ab} ± 7.7	65.9^{a} ± 11.6	64.6 ± 16.8	77.8^{a} ± 14.6
C x SD_2		33.0^{b} ± 4.3	52.6^{b} ± 8.6	61.3^{b} ± 13.8	63.4 ± 15.0	55.0^{c} ± 30.0
I x SD_1		35.4^{a} ± 5.0	55.0^{a} ± 8.0	69.4^{a} ± 13.1	62.8 ± 17.2	83.2^{a} ± 15.4
I x SD_2		32.6^{b} ± 4.9	53.3^{ab} ± 8.8	60.6^{b} ± 14.5	67.1 ± 15.7	70.0^{b} ± 19.0
P value						
LR		0.77	0.02	0.14	0.41	< 0.01
SD	< 0.01	< 0.01	0.07	< 0.01	0.16	< 0.01
LR x SD		0.03	0.04	0.02	0.054	< 0.01

a to c different letters in each column indicate statistical significance.

also in the 1st, 2nd and 4th week of age. Application of the intermittent light regime and lower stocking density at the same time increased the broiler gains in every week. At the age of 6 weeks, the greatest difference was between treatment with the intermittent light regime and lower stocking density and treatment which until recently had characterized intensive broiler production, that is, continuous light regime and higher stocking density.

Quality traits of carcass and tibia are presented in Tables 2, 3 and 4, separately, according to gender of broilers, considering already known predisposing differences caused by broiler gender.

Light regime demonstrated significant effect on breast depth index determined on carcasses from male chickens (Table 2), which in conditions of intermittent regime was increased by 0.6 index units. The effect of stocking density was even more pronounced. In conditions of lower stocking density, indices of shank length, keel length, breast depth and thigh girth were significantly ($p < 0.01$) higher. As a result of this, also in treatments which included lower stocking density, regardless of the light regime, better results for body development were realized by male chickens. Gender of chickens caused different responses to the effect of studied factors. Namely, female chickens improved significantly the body development expressed by indices for all measures in conditions of intermittent regime. Improvements ranged from 0.9 for thigh girth to 2.1 index units for shank length. Differences between studied stocking densities in regard to body development of female chickens were at the level of significance of $p < 0.01$. The effect of interaction influence of light regime and stocking density was similar to one established for male chickens.

Yields of major carcass parts in broiler carcass differentiated according to gender are presented in Table 3. In the carcass that form male chickens, the yield of breast growth significantly ($p < 0.01$) in conditions of lower stocking density, whereas the light regime showed no statistically significant influence, as well as interaction of observed factors. On carcasses from female chickens the principal effects of studied factors were confirmed ($p < 0.01$) but not of their interaction. Yield of breast was significantly higher in conditions of continuous light regime (lower stocking density), whereas in conditions of higher stocking density yield of drumstick in the carcass was higher ($p < 0.05$).

In accordance to established larger increase of chickens in conditions of lower stocking density, also higher ($p < 0.01$) surface of the cross section of tibia from male and female chickens was determined, whereas the application of various light regimes caused no statistically significant differences in observed trait (Table 4). Breaking force, as an absolute indicator of bone firmness, was higher in conditions of lower stocking density with statistically confirmed difference only in male chickens. Specific breaking force showed absence of significant effects of studied environmental factors.

DISCUSSION

More intensive growth of broilers in conditions of intermittent light regime is in accordance with results of previous studies. However, transition from continuous to

Table 2. Weight and conformation of chicken carcasses differentiated by gender.

Treatment	Carcass weight (g) (Mean ± SD)	Conformation measures (Mean ± SD)				
		BW/SL (g/mm)	BW/KL (g/mm)	BW/BS (g/mm)	BA (degrees)	BW/TG (g/mm)
Male						
C	1577.7 ± 159.3	30.1 ± 2.2	22.9 ± 1.8	23.4 ± 1.9	115.1 ± 5.6	15.7 ± 1.2
I	1616.4 ± 155.0	30.3 ± 2.8	23.5 ± 2.6	24.1 ± 1.9	114.7 ± 8.3	15.9 ± 1.2
SD_1	1660.2 ± 150.9	31.1 ± 2.5	23.9 ± 2.2	24.4 ± 2.0	115.6 ± 5.8	16.3 ± 1.3
SD_2	1539.4 ± 141.1	29.4 ± 2.2	22.6 ± 2.1	23.1 ± 1.7	114.2 ± 8.2	15.3 ± 0.9
C x SD_1	1713.9^{a} ± 126.5	31.6 ± 2.8	24.8^{a} ± 2.4	25.2^{a} ± 1.7	115.9 ± 6.3	16.6 ± 1.1
C x SD_2	1534.4^{b} ± 128.0	29.3 ± 2.3	22.5^{b} ± 2.2	23.1^{b} ± 1.5	113.6 ± 9.7	15.3 ± 1.0
I x SD_1	1606.4^{b} ± 156.8	30.6 ± 2.1	23.1^{b} ± 1.7	23.6^{b} ± 1.9	115.2 ± 5.5	16.0 ± 1.3
I x SD_2	1546.0^{b} ± 160.1	29.4 ± 2.2	22.7^{b} ± 1.9	23.0^{b} ± 1.9	114.9 ± 6.0	15.4 ± 0.8
P value						
LR	0.12	0.43	0.12	0.03	0.85	0.24
SD	<0.01	<0.01	<0.01	<0.01	0.39	<0.01
LR x SD	0.05	0.29	0.03	0.05	0.52	0.22
Female						
C	1304.2 ± 133.0	26.7 ± 2.2	20.6 ± 2.2	20.9 ± 1.7	114.9 ± 5.0	13.7 ± 1.1
I	1397.6 ± 110.8	28.8 ± 1.7	21.9 ± 1.4	22.4 ± 1.2	115.7 ± 4.8	14.6 ± 0.9
SD_1	1398.6 ± 122.3	28.5 ± 2.1	22.0 ± 1.8	22.2 ± 1.3	116.3 ± 5.5	14.6 ± 1.0
SD_2	1298.4 ± 121.4	26.8 ± 2.1	20.5 ± 1.9	21.0 ± 1.7	114.3 ± 4.2	13.7 ± 1.1
C x SD_1	1382.4^{a} ± 133.7	29.2 ± 1.8	22.1^{a} ±1.6	22.7^{a} ± 1.1	116.4 ± 4.9	14.8^{a} ± 0.8
C x SD_2	1233.6^{b} ± 85.7	28.4 ± 1.5	21.6^{a} ± 1.3	22.2^{a} ± 1.3	115.0 ± 4.9	14.5^{a} ± 1.0
I x SD_1	1416.6^{a} ± 109.4	27.9 ± 2.2	21.9^{a} ± 2.0	21.8^{a} ± 1.4	116.2 ± 6.1	14.4^{a} ± 1.2
I x SD_2	1378.5^{a} ± 112.2	25.6 ± 1.6	19.5^{b} ± 1.8	20.1^{b} ± 1.4	113.8 ± 3.5	13.1^{b} ± 0.7
P value						
LR	<0.01	<0.01	<0.01	<0.01	0.54	<0.01
SD	<0.01	<0.01	<0.01	<0.01	0.1	<0.01
LR x SD	0.04	0.08	0.02	0.04	0.67	0.03

a to b different letters in each column indicate statistical significance. BW, pre-slaughter body weight; SL, shank length; KL, keel length; BD, breast depth; BA, breast angle; TG, thigh girth.

intermittent light regime often changes the broiler growth curve often demonstrating first the depressive effect on initial growth followed by phase of compensatory growth (Buyse et al., 1994, 1996; Ozkan et al., 2006). Based on established continuous increase of daily gain, absence of depressive phase can be stated, contrary to earlier mentioned results. However, in agreement with results of said authors, positive effect of intermittent light regime increases with the age of chickens. Changes in the feeding activity, that is, intensive consumption of feed during photo period, with peaks in consumption of feed at the beginning and end of photo period and period of rest during the dark period, are more pronounced and more significant in older chickens.

The effect of lower stocking density on average body gain of chickens was demonstrated at the end of the first week, as the result of better orientation in space and finding of feeders. Most of authors stated that, maximum effect of reduced stocking density on growth can be expected in the last fattening phase when the lack of space is most present (Edriss et al., 2003; Dozier et al., 2006), which is in agreement with results obtained in present, but also in previous study (Skrbic et al., 2009), indicating the need for more considerable reduction of stocking density in order to achieve desired benefit in broiler growth.

Upon completion of the final fattening phase, that is, fattening period, positive effect of application of intermittent light regime as well as lower stocking density on broiler growth was confirmed, whereas their simul-taneous application resulted in the significantly highest gain compared with other treatments. However, from the aspect of statistical significance of obtained differences, stocking density had greater effect compared with studied

Table 3. Yields of major carcass parts from chickens differentiated by gender.

Treatment	Yield (% BW) (Mean ± SD)		
	Breast	**Thighs**	**Drumsticks**
Male			
C	20.5 ± 1.8	9.8 ± 0.7	11.6 ± 0.6
I	19.9 ± 1.2	10.0 ± 0.6	11.6 ± 0.6
SD_1	20.5 ± 1.3	9.9 ± 0.6	11.5 ± 0.5
SD_2	19.8 ± 1.7	9.9 ± 0.7	11.7 ± 0.6
C x SD_1	20.3 ± 1.0	10.0 ± 0.7	11.6 ± 0.6
C x SD_2	19.6 ± 1.3	9.9 ± 0.5	11.7 ± 0.7
I x SD_1	20.8 ± 1.6	9.8 ± 0.4	11.4 ± 0.5
I x SD_2	20.1 ± 2.1	9.8 ± 0.9	11.7 ± 0.7
P value			
LR	0.1	0.17	0.69
SD	0.04	0.99	0.16
LR x SD	0.94	0.85	0.34
Female			
C	21.2 ± 1.0	9.4 ± 0.7	11.6 ± 0.5
I	20.2 ± 1.2	9.4 ± 0.5	11.4 ± 0.7
SD_1	21.1 ± 1.1	9.5 ± 0.5	11.4 ± 0.6
SD_2	20.5 ± 1.2	9.3 ± 0.7	11.7 ± 0.5
C x SD_1	20.8 ± 1.2	9.4 ± 0.6	11.2 ± 0.6
C x SD_2	19.7 ± 1.0	9.4 ± 0.5	11.7 ± 0.6
I x SD_1	21.4 ± 1.0	9.6 ± 0.4	11.6 ± 0.6
I x SD_2	21.1 ± 0.9	9.3 ± 0.9	11.7 ± 0.5
P value			
LR	<0.01	0.87	0.16
SD	<0.01	0.45	0.05
LR x SD	0.1	0.34	0.12

light regimes. The results pointed to reasonable application of intermittent light regime in conditions of higher stocking densities in order to mitigate the negative impact on broiler growth.

Slaughter carcass quality of broilers is determined by its weight, conformation (body development), yields of major carcass parts, but also absence of various leg deformities and damages. Considering the specificity of the method used for investigation of the carcass conformation, it is mainly used in selection-breeding purposes and only few studies deal with this topic, especially from the aspect of the influence of environment factors. Index values of conformation measures which represent the ratio between body weight and certain linear measure, as comparable indicators of the body structure, indicate positive effect of lower stocking density on length of tubular bones, development and curvature of the breast (Garcia et al., 2002), development of hind limbs. The effect of stocking density was confirmed for both genders, however, response of male chickens was more expressed ($p < 0.01$) compared with female gender ($p < 0.05$), which is in agreement with results of Bhardway and Mohapatra (1996), on significant effect of gender on conformation of broiler carcass from five genotypes reared in various stocking densities. Different growth curves in male and female birds (Scheuermann et al., 2003) caused differences in response to light effects.

Better carcass conformation in conditions of lower stocking density is as a basis for development of musculature and higher yields of meaty carcass parts. However, established better development of hind limbs was insufficient in relation to increase of body weight for any significant increase of yield of thigh and drumstick, which in female chickens resulted in higher yield of drumstick in higher stocking density. Similar results were obtained also by Lewis et al. (1997), whereas, Mendes et al.

Table 4. Physical properties of tibia from broilers separated by gender.

Treatment	Tibia		
	Cross surface (mm^2) (Mean ± SD)	Breaking force (kg) (Mean ± SD)	Spec. breaking force (kg/mm^2) (Mean ± SD)
Male			
C	57.63±6.66	40.89±7.35	0.71±0.12
I	56.09±7.70	42.06±8.03	0.75±0.13
SD_1	59.29±7.77	43.52±7.67	0.74±0.13
SD_2	54.44±5.84	39.60±7.31	0.73±0.13
C x SD_1	59.09^{a}±7.55	44.23±8.26	0.75±0.14
C x SD_2	53.57^{b}±7.02	40.24±7.52	0.76±0.13
I x SD_1	59.49^{a}±8.18	42.82±7.15	0.73±0.13
I x SD_2	55.58^{ab}±3.67	38.75±7.15	0.70±0.13
P value			
LR	0.42	0.38	0.13
SD	< 0.01	0.02	0.65
LR x SD	0.05	0.98	0.61
Female			
C	45.51±6.57	34.58±6.97	0.76±0.12
I	45.09±6.39	33.64±6.36	0.75±0.12
SD_1	47.46±6.56	35.54±7.10	0.75±0.12
SD_2	43.29±5.71	32.83±6.02	0.76±0.13
C x SD_1	48.27±7.47	36.44±7.79	0.75±0.09
C x SD_2	43.01±4.51	32.89±5.81	0.77±0.15
I x SD_1	46.55±5.46	34.54±6.33	0.75±0.15
I x SD_2	43.64±7.06	32.75±6.44	0.75±0.09
P value			
LR	0.71	0.51	0.66
SD	< 0.01	0.09	0.71
LR x SD	0.42	0.57	0.81

a to b different letters in each column indicate statistical significance.

(2002) denied the presence of significant effect of stocking density on yield of breast and thigh with drumstick and concluded significant effect of chicken gender (Bogosavljević-Bošković et al., 2009) on studied traits.

Data on yields of breast, thigh and drumstick in continuous and intermittent light regime showed absence of significant differences, except for yield of breast in female chickens which was significantly higher in continuous light regime. These data point the significance of physical activity for development of breast musculature despite better predisposition in regard to better conformation determined for chickens in intermittent light regime. In addition, results obtained by Lien et al. (2007) show higher yield of breast when 23 h photo period was implemented compared with restrictive photo period of 18 h. However, from the aspect of yield of white breast meat, significance of established differences was eliminated.

Quality of broiler carcasses from conventional production is often diminished due to deformed and broken legs. In addition to the results of continuous selection of broilers on fast growth and higher yield of breast in carcass which resulted in significant conformation changes (Reddish and Lilburn, 2004), problem is often in reduced physical activity of broilers (Lewis et al., 1997; Sorensen et al., 2000) and mechanical injuries of broilers in conditions of high stocking density, which are more frequent in fast growing genotypes considering insufficient development and maturity of the skeleton. Physical activity influences some bone parameters, that is, surface of cortex cross section and at the same time improves their mechanical characteristics due to better blood supply and adequate mineralization (Vitorovic, 1992). Accordingly, breaking force of tibia was higher in chickens reared in lower than higher stocking density. Sorensen et al., (2000) and Sanotra et al. (2002) report also on positive effect of physical activity on quality of bones. Absence of

significant difference in breaking force of tibia between studied stocking densities of female chickens, despite established significant differences in surface of cross section of diaphysis, is probably a consequence of mutual relation of the cortex cross section and medullar cavity, which can influence greatly the quality of bones. Specific breaking force as a relative indicator of bone firmness eliminates the effect of body weight and development of the skeleton present in case of absolute indicator. Because of this, established differences in specific breaking force were non-significant.

Conclusions

Changes in the rearing conditions in regard to application of lower stocking density and intermittent light regime (restrictive photo period), ensure more intensive broiler growth, better body development that is, carcass conformation which represent basis for development of musculature and higher yields of major carcass parts, especially breast. Significant effect of the chicken gender can be concluded, especially in regard to the effect of light regime, which points need for further researches in this direction. Quality of tibia improved with increased physical activity of chickens reared in lower stocking density, but considering that only significance of absolute indicators was determined, it can be concluded that, only body weight had significant effect. In regard to current measures for preservation and improvement of animal welfare, application of lower stocking density and moderate photo period is justified also from the aspect of improvement of carcass quality.

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