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THE INFLUENCE OF TEMPERATURE AND HUMIDITY CONDITIONS ON PRODUCTIVITY AND WELFARE OF BROILER CHICKENS

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Abstract. The aim of the work was to determine the effect of thermal and humidity conditions on productivity and welfare of broiler chickens. Studies were conducted during the winter in two buildings (A and B) of similar technical and technological solutions, and different area indexes. It was found that broiler house A, with optimal density of birds (16.5 chickens per m^2) had temperature and air relative humidity ranged within the limits of zoohygienic recommendations. Whereas broiler house B where birds density was too highly (18.6 chickens per m^2) showed a slight deflection of these parameters from standard. Profitable management conditions of broiler chickens in the building A was reflected in higher body weight (2260 g), better feed conversion (1880 g · kg b.w.$^{-1}$) and lower mortality of birds (3.6%).

Keywords: broiler chickens, management conditions, productivity, welfare

INTRODUCTION

High productivity and optimum welfare conditions of broiler chickens can be achieved by optimizing farming environment, including its nutritional and technological components, and the microclimate of the premises. This last group of factors, especially the temperature-humidity system, is shaped by the building itself, the chickens housed therein, and the outdoor climate [Hamrita and Mitchell 1999, Kołacz and Bodak 1999, Abeyesinghe et al. 2001, McLean et al. 2002, Freire et al. 2003]. Environmental conditions in the rearing of broiler chickens do not always remain within the limits of zoohygienic standards, as demonstrated by many authors [Dobrzański 1983, Bombik and Saba, 1996, Cooper et al. 1998, Özkan et al. 2003, Tuyttens et al. 2005, Skomorucha and Herbut 2006, Skomorucha et al. 2007].

The Regulation [2010], dealing with animal welfare, states the minimum breeding environment requirements for broiler chickens. Also, other authors emphasize the need to op-

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timize the rearing conditions of broiler chickens [Herbut 1997, Herbut et al. 1997, Sokołowicz et al. 2000, Rachwał 2002, 2005, Skomorucha and Herbut 2006, Mazanowski 2011].

The aim of this study was to determine the effect of thermal and humidity conditions on productivity and welfare of broiler chickens.

MATERIAL AND METHODS

The study was carried out in two broiler houses (A and B), located in the north-western part of Mazovia, Poland. The number of Ross 308 in the first week of the cycle broiler chickens in house A was 20,000 units, while in B 15,000 units. The broiler houses had similar technical and technological solutions (negative pressure mechanical ventilation, artificial lighting, heating with gas heaters, tubular feeders, drip drinkers), but differed in surface area indicators (Table 1). On both farms, broiler chickens were fed according to the recommendations (Starter until the third week of age, followed by Grower and, in the last week of the cycle, Finisher.

The scope of studies included an inventory of the broiler houses and direct measurements of two main microclimate parameters: temperature and relative humidity.

Surface are indices were calculated on the measurements of the dimensions of the premises. Measurements of selected physical parameters of air were carried out in winter (January–February 2009), using the methods by Kośla [2011]. The temperature and relative air humidity were measured using a weekly thermo-hygrograph (continuous measurements) and a thermo-hygrometer COMET D3121 (instantaneous measurements). These parameters were recorded at 1, 3, and 6 weeks of age of the broiler chickens. It should be noted that measurements using the thermo-hygrometer were performed three times a day (at approx. 8.00, 13.00, and 18.00 hrs). The measurements in each building were carried out in places occupied by chickens (at the height of chicken's back) at three locations: in the central part of the broiler house and at a distance of 5–7 m from either gable wall. Simultaneously were performed measurements of temperature and relative humidity outside the buildings.

The results obtained were processed statistically [Grużewska and Malicki, 2002] and are summarized as: minimum and maximum values, arithmetic mean ($\overline{x}$) and coefficient of variation (V%).

Production performance evaluation was based on body weight of broiler chickens at 42 days of age, and feed consumption per 1 kg gain, as well as on the rate of deaths of the chickens.

RESULTS AND DISCUSSION

The studied facilities differed in size. The surface area of the production room in broiler house A was 1170 m^2, whereas that in house B, 720 m^2 (Table 1), with the flock sizes, respectively, 19,286 and 14,218 broilers (in the sixth week of the cycle). Stocking density at the final stage of finishing in broiler house A was 16.5 chickens per 1 m^2, which was 2.1 chicken · m^{-2} lower compared to building B. Pursuant the Regulation [2010] on the conditions of livestock animals housing, the maximum density of chickens at age 5 weeks and more should not exceed 17 birds · m^{-2}. This level was exceeded in broiler house B by 1.6 birds · m^{-2}, which could have resulted in microclimate deviations from the hygienic optimum, and led in consequence to lower production performance and poorer welfare conditions of the chickens.

Table 1. Area indexes of the broiler houses
Tabela 1. Wskaźniki powierzchniowe brojlerni

Specification Wyszczególnienie	Symbol of broiler house – Symbol brojlerni	
	A	B
Building measurements, m Wymiary budynku, m		
length – długość	90.0	60.0
width – szerokość	13.0	12.0
Building area, m^2 Powierzchnia budynku, m^2	1170.0	720.0
Number of birds in the 42nd day Liczba ptaków w 42. dniu	19 286.0	14 218.0
Area index, unit · m^{-2} Wskaźnik powierzchniowy, szt.· m^{-2}	16.5	18.6

The data presented in Table 2 reveal that the average air temperature in both poultry houses decreased gradually in the subsequent weeks of rearing (from 31.5 to 18.3°C in building A and from 30.1 to 19.5°C in facility B). The extreme values of this parameter were as follows: 33.4–17.9°C, in broiler houses A, and 33.2–18.4°C, in B.

Table 2. The values of air temperature (ºC) inside and outside the broiler houses in the winter period
Tabela 2. Wartości temperatury powietrza (ºC) wewnątrz i na zewnątrz brojlerni w okresie zimowym

Weeks of rearing Tygodnie odchowu		Inside – Wewnątrz		Outside – Na zewnątrz
		A	B	
1	min.	30.2	28.6	–11.5
	max.	33.4	33.2	–2.3
	$\bar{x}$	31.5	30.1	–4.2
	V%	3.9	8.0	32.1
3	min.	24.3	22.9	–7.7
	max.	25.7	25.2	+1.8
	$\bar{x}$	25.1	23.7	–2.3
	V%	7.8	6.6	19.2
6	min.	17.9	18.4	–5.9
	max.	20.2	21.7	+0.5
	$\bar{x}$	18.3	19.5	–0.4
	V%	6.5	8.9	18.3

In both broiler houses air temperature in the first week of rearing cycle was similar (from 28.6 to 33.4°C), however, in facility B the lowest measured temperature was lower than the recommended minimum. Optimum temperature in the first week of rearing, according to Mazanowski [2011] and the Regulation of the Minister of Agriculture and Rural Development of 15 Feb., 2010, on requirements and procedures in livestock animals husbandry [Rozporządzenie Ministra Rolnictwa i Rozwoju Wsi z dnia 15 lutego 2010 No. 56, item 344] should remain in the range 30–34°C. According to Skomorucha and Herbut [2006], the mean air temperature in a broiler house in the 1st week of rearing was lower 27.6°C. In the third week of rearing, air temperature, according to the aforementioned Regulation [2010], should remain within the range 24–26°C.

Air temperature in facility A met the said requirements. On the other hand, the lowest temperature recorded in farm B (22.9°C) was too low in terms of animal hygienic standards. The mean temperature in building A was 25.1°C and 1.4°C higher compared to B. Skomorucha and Herbut [2006], who studied the welfare conditions of broiler chicken farming, observed higher values of air temperature in the 3rd week of rearing (26.1°C). Analyzing the 6th week of rearing, it should be stated that the avderage values of air temperature in both facilities remained within the optimum range. In broiler house B, however, the highest temperature slightly exceeded the recommendations for air temperature. It should also be noted that the stocking density in farm B in the 6th week of rearing was also higher as compared with farm A. Pursuant to the Regulation [2010] on aminal welfare, the optimum indoor air temperature for broiler chickens in the final stage of finishing should range from 16 to 20°C. However, Mazanowski [2011] recommends about 19°C for broiler chickens from the 4th week of rearing until the end of fattening. Skomorucha and Herbut [2006] reported that broiler chickens at 6 week of age were kept in the mean air temperature of 19.6°C.

Air temperature during the winter was maintained within the optimum range in both broiler houses, which was possible due to a use of propane gas heaters and, additionally in places, infra-red heat lamps.

Analyzing air humidity in the studied facilities (Table 3), it should be stated that mean relative air humidity in subsequent weeks of the rearing cycle (1, 3 and 6) was lower in broiler house A (respectively: 61.4, 67.5 and 68.8%) than in broiler house B (respectively, 66.1, 72.7 and 75.6%). Also extreme values of this parameter in subsequent weeks of finishing were lower in facilities A. Sosnówka and Herbut [1997] report that in first weeks of age, the optimum relative humidity should be 70%, while from the third week until the end of the cycle – 60%.

In the studies by Skomorucha and Herbut [2006], carried out on broiler chickens in the subsequent weeks of fattening (1, 3 and 6), the average relative humidity was, respectively, 71.7, 57.7 and 69.7%. An analysis of the obtained results of air humidity, it should be noted that in both broiler houses a slight deviation from the recommended standards of animal hygiene was observed. It should be noted that in object B both the average and maximum relative humidity values were exceeded in the subsequent weeks of chicken rearing. According to Mazanowski [2011], the optimal value of this parameter for broiler chickens should be 60–65%, with an allowable deviation of 55% to 70%.

Table 3. The values of air relative humidity (%) inside and outside the broiler houses in the winter period
Tabela 3. Wartości wilgotności względnej powietrza (%) wewnątrz i na zewnątrz brojlerni w okresie zimowym

Weeks of rearing Tygodnie odchowu		Inside – Wewnątrz A	Inside – Wewnątrz B	Outside – Na zewnątrz
1	min.	59.1	56.9	59.6
	max.	63.9	72.8	68.5
	$\overline{x}$	61.4	66.1	64.0
	V%	4.5	6.0	11.6
3	min.	64.6	69.3	58.9
	max.	72.6	78.5	72.9
	$\overline{x}$	67.5	72.7	67.2
	V%	7.9	8.7	26.4
6	min.	58.1	69.4	57.3
	max.	73.7	81.4	80.8
	$\overline{x}$	68.8	75.6	72.1
	V%	9.0	11.2	25.0

Temperature-humidity conditions in the studied facilities in winter significantly affected the efficiency of the production cycle (Table 4). The average body weight at 6 weeks of fattening in building A was 2260 g and was higher by 110 g compared with those kept in the house B. Skomorucha and Herbut [2006] reported a similar body weight of broilers (2017 g). However Mazanowski [2011] state that Ross 308 broiler chickens should attain a higher body weight, 2475 g, in consequence of 6 weeks of intensive feeding. Feed intake per 1 kg body weight was from 1880 g, in broiler house A, to 1960 g, in B. Other studies [Skomorucha and Herbut 2006] show that feed intake per 1 kg of weight gain can be higher, i.e. 2300 g. Mazanowski [2011] reports that at body weight of 2475 g of a six-week broiler, feed consumption should be approx. 1720 g. The rate of mortality for the whole finishing period in facility A was 3.6% and was 1.6% lower compared to farm B. It should be noted that in the initial period of rearing, the mortality of broiler chickens in both farms were higher in comparison with the final period of the cycle. In studies by other authors [Skomorucha and Herbut 2006, Skomorucha et al. 2007], the mortality rate during the six-week rearing cycle of broiler chickens was, respectively, 4.33 and 3.33%. The Council Directive [2007], stating the rules of the protection of broiler chickens, gives the maximum level of 3% deaths for the whole fattening period. Also, studies by other authors [Jon et al. 1998, Hamrita and Mitchell 1999, Hall 2001, McLean et al. 2002, Dawkins et al. 2004] demonstrated the strong impact of the maintenance conditions of birds on their welfare and productivity.

Table 4. Results rearing of broiler chickens
Tabela 4. Wyniki odchowu kurcząt brojlerów

Specification Wyszczególnienie	Day of rearing Dzień odchowu	A	B
Body weight, g Masa ciała, g	42	2260	2150
Feed intake, g · kg^{-1} body weight Zużycie paszy, g · kg^{-1} masy ciała	1–42	1880	1960
Mortality, % Upadki, %	1–21	2.1	3.0
	22–42	1.5	2.2
	1–42	3.6	5.2

CONCLUSIONS

The results indicate that the formation of thermal and humidity conditions in broiler houses depend, among other factors, on the stocking density of birds. In farm A, the optimal density of broiler chickens (16.5 birds · m^{-2}), temperature, and relative humidity ranged within the recommended standards. However, in broiler house B, where the surface area index was too high (18.6 units · m^{-2}), a slight deviation of these parameters from the standards was observed. Better living conditions for broiler chickens in the facility A affected the final performance of the production cycle: higher body weight (2260 g), lower feed intake per 1 kg of gain (1880 g · kg^{-1} b.w.) and lower mortality (3.6%).

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WPŁYW WARUNKÓW TERMICZNO-WILGOTNOŚCIOWYCH NA PRODUKCYJNOŚĆ I DOBROSTAN KURCZĄT BROJLERÓW

Streszczenie. Celem pracy było określenie wpływu warunków termiczno-wilgotnościowych na produkcyjność i dobrostan kurcząt brojlerów. Badania przeprowadzono w okresie zimowym w dwóch budynkach (A i B) o podobnych rozwiązaniach techniczno-technologicznych i różnych wskaźnikach powierzchniowych. Stwierdzono, że w brojlerni A o optymalnym zagęszczeniu ptaków (16,5 szt. · m^{-2}) temperatura i wilgotność względna powietrza kształtowała się w granicach zaleceń zoohigienicznych. Natomiast w brojlerni B, gdzie obsada ptaków była za wysoka (18,6 szt. · m^{-2}), wykazano niewielkie odchylenia tych parametrów od norm. Korzystniejsze warunki utrzymania kurcząt brojlerów w obiekcie A miały swoje odzwierciedlenie w wyższej masie ciała (2260 g), lepszym wykorzystaniu paszy (1880 g · kg m.c.$^{-1}$) i niższej śmiertelności ptaków (3,5%).

Słowa kluczowe: dobrostan, kurczęta brojlery, produkcyjność, warunki utrzymania

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