EFFECT OF AN EARTH TUBE HEAT EXCHANGER ON BROILER HOUSE CLIMATE IN THE SUMMER PERIOD

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Introduction

One of the factors responsible for improved performance of poultry is adequate indoor climate, which is largely affected by thermal environmental factors, the latter conditioning the exchange of heat between birds and the environment (Herbut et al., 1993).

Recent practice shows that summer heats in Poland often cause the recommended indoor climate standards to be exceeded (Sokolowicz and Herbut, 2004). This result in excessive indoor temperature, which, combined with too low or too high ambient temperature, makes birds hyperthermic. The heat stress causes losses due to poorer productivity, compromised health and widespread mortality (Reddy, 2000).

The trend is towards solutions that do not increase the production costs while allowing for optimum temperature to be maintained without unfavourable fluctuations and excessive cooling of birds. Analysis of relevant studies indicates that new possibilities are offered by earth heat exchangers, which can be used to heat inlet air during winter months and to cool it during the summer heats (Alchalabi, 2001; Bieda and Kozbial, 2000; Bieda et al., 2001).

The aim of the present study was to determine the effect of an earth-tube heat exchanger (ETHE) on the indoor climate of a broiler house during the summer heats.

Material and methods

The study was performed at the Experimental Station of the National Research Institute of Animal Production in Rossocha Ltd. during the summer production cycle in two modern broiler houses, each holding 15 200 Starbro broilers.

Group I was the control broiler house, in which chickens were raised under standard conditions. Group II was the experimental broiler house with an ETHE installed to optimize thermal conditions during the growth of chickens.

Broiler chickens were kept on litter until day 42 and fed with standard diets. Throughout the experiment we recorded basic parameters of microclimate inside and outside the broiler house: air temperature (3 times a day at 8^{00}, 14^{00} and 18^{00}), relative humidity, water vapour pressure, air motion, and “dry” cooling (measured once a day at 14^{00}).

On day 42 of the experiment, the European Production Index (EPI) was calculated from the productive results to compare performance of birds of both groups.

The results were analyzed statistically using variance analysis and significant differences were estimated with Duncan’s multiple range test.

Results

Generally lower air temperature was characteristic of the broiler house equipped with ETHE (Tab. 1). Statistically significant and highly significant differences between the buildings were found on days 21, 28 and 35 of broiler growth in the afternoon hours.

In the experimental building, stronger air motion and “dry” cooling were observed (Tab. 2). A highly significant difference in these parameters of indoor climate was observed on day 28 of chicken rearing.

Birds from the experimental facility showed higher EPI compared to birds from the control house (256 vs. 230 points) (Fig. 1).

Discussion

Analysis of the measurements indicates that approximately 2-3.5°C lower temperature was obtained in the building equipped with ETHE, especially in the afternoon hours. Similar results were obtained by Bieda et al. (2001), whose preliminary study revealed approximately 2.5 K higher internal air temperature in the control house in which the air-cooling heat exchanger had not been installed. Shingari et al. (1995) demonstrated that air temperature in the building with ETHE decreased by approximately 6-7 K compared to the control house. A considerable reduction in temperature and slight 24-hour fluctuations of temperature inside the building were also shown by Alchalabi (2001).

Essential to poultry facilities is cooling, which is directly related to air temperature, humidity and motion. In our study, a clearly higher cooling rate was noted in the experimental group. This is probably due to higher air motion and lower temperature in the broiler house equipped with ETHE, indicating that thermal conditions were more optimal for broilers from the ETHE building (Dobrzanski amd Gajek, 1983), as reflected in higher EPI (230 vs. 256 pts).

Conclusions

The application of additional cooling in the form of an earth-tube heat exchanger installed in the ventilation system of a broiler house had an influence on indoor climate mainly by lowering internal temperature in the building by approx. 2 – 3.5°C in relation to the control house, thus increasing heat welfare. Lower temperature in the experimental facility contributed to better productive results of the birds, as evidenced by higher EPI.

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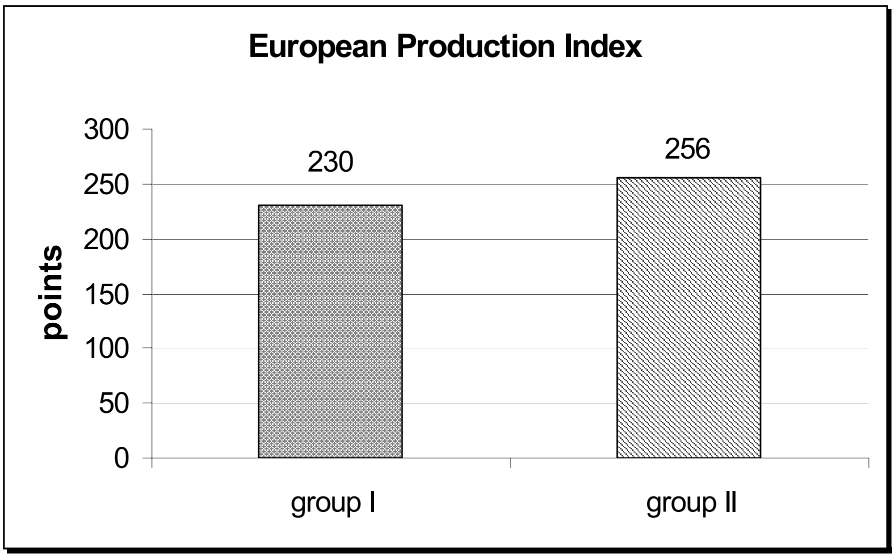
Fig. 1. European Production Index



Tab. 1. Air temperature (°C) inside and outside the broiler house

Day of growth	Indoor						Outdoor
	8^{00}		14^{00}		18^{00}		
	Group						
	I	II	I	II	I	II	
7	27.9	27.4	27.6	27.1	27.7	27.3	***19.1***
14	25.4	25.3	27.7	27.7	26.7	26.2	***29.5***
21	23.3	21.5	27.5 a	25.6 b	28.2 a	25.5 b	***29.7***
28	22.4	21.8	24.8 A	22.1 B	24.2 A	21.8 B	***23.0***
35	21.5	20.7	27.4	25.3	27.3 a	24.8 b	***27.5***
42	20.1	18.7	21.8	20.0	21.0	19.4	***19.2***

Tab. 2. Other parameters of microclimate inside and outside the broiler house

Day of growth	Relative humidity of air (%)			Water vapour pressure (hPa)			Air motion (m/s)			"Dry" cooling (mW/cm^2)		
	inside		Outside	inside		Outside	inside		Outside	Inside		Outside
	group			group			group			group		
	I	II		I	II		I	II		I	II	
7	***70.00***	***72.00***	63.25	25.69	25.89	13.08	0.528 A	0.197 B	1.39	18.67	14.97	50.04
14	***66.00***	***64.33***	61.00	24.44	23.48	23.17	0.176	0.795	1.463	13.52	20.46	22.48
21	***52.67 A***	***61.00 B***	55.00	19.47	20.18	21.85	1.547	1.817	1.926	26.53	34.50	22.59
28	***78.33 A***	***74.00 B***	74.50	24.53 A	20.93 B	19.85	0.261 A	0.601 B	0.979	19.83 A	28.42 B	34.31
35	***66.33***	***67.00***	67.50	24.18 a	21.64 b	23.21	0.713	0.995	1.190	22.95	28.00	24.88
42	***84.00***	***85.00***	80.25	21.91	20.26	17.53	0.230	0.357	0.454	23.84	28.87	33.90

A,B – VALUES MARKED WITH DIFFERENT LETTERS DIFFER SIGNIFICANTLY ($P \leq 0.05$)

A, B – VALUES MARKED WITH DIFFERENT LETTERS DIFFER HIGHLY SIGNIFICANTLY ($P \leq 0.01$)