

The Influence of Cold Conditioning on the Performance of the Broiler Chicken

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Abstract: The effect of short-term cold exposure on the performance of 600 commercial Ross 308 male broiler chickens was examined. On the fifth and sixth days of life the trial group was exposed to 15 °C ambient temperature for 3 h, both days, while the control group was kept under conventional brooding conditions. Thereafter, both control and trial birds were exposed to standard rearing temperatures until the 21st day, and from the 21st day to slaughter they were exposed to 15 °C ambient temperature. The mortality rate was significantly lower in the trial group (5%) compared to the control group (11%). The differences between body weight (control group: 2475.9 g; trial group: 2423.7 g) and feed conversion ratio (FCR) (control group: 1.95; trial group: 1.92) were not statistically significant. Performance and livability were not negatively affected by short-term cold exposure. It may be concluded that early age short-term cold conditioning improves thermotolerance to cold weather in broiler chickens in their later life.

Key Words: Broiler, cold exposure, thermotolerance

Broiler Piliçlerde Soğuğa Maruz Bırakmanın Performansa Etkisi

Özet: Ross 308 ırkı 600 adet erkek broiler piliç üzerinde kısa süreli soğuğa maruz bırakmanın performansa etkisi incelendi. Deneme grubu 5. ve 6. günlerde 3 saat boyunca 15 °C'lik çevresel sıcaklığa maruz bırakılırken, kontrol grubu sahada uygulanan standart sıcaklığa maruz bırakıldı. Daha sonra 21. güne kadar hem deneme hem de kontrol grubu standart sıcaklığa ve 21. günden kesime kadar 15 °C'lik çevresel sıcaklığa maruz bırakıldılar. Deneme grubunda ölüm oranı (% 5) kontrol grubuna göre (% 11) önemli derecede düşük bulundu. Gruplar arasında canlı ağırlık (kontrol grubu 2475,9 g; deneme grubu 2423,7 g) ve yemden yararlanma oranları (kontrol grubu 1,95; deneme grubu 1,92) arasında istatistiksel olarak önemli bir fark bulunmadı. Kısa süreli soğuk uygulaması performans ve yaşama gücünü olumsuz yönde etkilemedi. Sonuç olarak broiler piliçleri erken yaşta kısa süreli soğuğa maruz bırakmanın ileriki yaşlarda soğuk hava şartlarına karşı dayanıklılığı geliştirdiği söylenebilir.

Anahtar Sözcükler: Broiler, soğuğa maruz bırakma, dayanıklılık

Introduction

Contrary to standard rearing conditions, broiler chicks are exposed, from time to time, to cold conditions because of sudden changes in environmental temperature. Cold days associated with poor house construction create an unsuitable environment for broilers. This increases the risk of significant economic loss to the producer if the birds are not housed in a well-controlled environment. Increases in mortality and reduced performance due to the cold conditions results in reduced profitability. In some publications (1,2) it has been reported that resistance can be developed, to a

certain extent, against cold conditions by exposing the chickens to low environmental temperatures for a short time (3 h) during the early period of life (3).

Adaptation to ambient conditions depends on a mechanism called epigenetic adaptation. Chickens can be better conditioned for thermal stress tolerance during the pre-natal and early post-natal period by the epigenetic adaptation mechanism (4,5). Under these conditions there is a period during which thermotolerance can be improved by thermal conditioning, without impairing performance (1,2). The ability of chicks to regulate body temperature during the post-natal period was reported to

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increase in an age-dependent manner, and to reach a completely homeothermic level by the age of 10 days (6). Cold exposure slightly, but significantly, increased feed intake in cold-exposed chicks, but did not change body weight or body weight gain during the period of the experiment, which was terminated at 14 days of age (7).

The purpose of this experiment was to determine the effects of early-age cold conditioning on the subsequent performance of broiler chickens.

Materials and Methods

The trial included 600 male Ross 308 broiler chicks. The experimental period began with the arrival of the chicks from a commercial hatchery and ended 42 days later. Prior to arrival, all chicks received the same vaccinations as commercial broiler flocks at the hatchery. They were divided into 2 groups of 300 birds, a control and a trial group, each of which was subdivided into 10 groups. The chicks were reared on the floor in pens in a curtain-sided broiler house. Pine wood shavings were used as the litter material. The pens were 2 m² and the stocking density was 15 chicks per square meter. Pens were partitioned using wire mesh 75 cm high and each pen was equipped with a hanging tube feeder. Feed and water were provided ad libitum. The daily lighting regimen was 23/1 h light/dark.

The trial and control groups were separated on the fifth day. On the fifth and sixth days the trial group was exposed to a temperature of 15 °C for 3 h, both days. A cold chamber was prepared in the experimental poultry house prior to cold exposure. The trial birds were carried to the cold chamber in unused, clean, cardboard chick boxes. Following cold exposure the chicks were returned to their trial pens.

According to the statistical data received from the General Directorate of Meteorology, the average ambient temperature for the first 10 days of the trial was 18.4 °C, between the 11th and 20th days it was 18.9 °C, and from the 21st to 42nd days, 15.3 °C. Maximum and minimum temperatures were 23.8 °C and 9.7 °C, and the average humidity was 59.4% throughout the experiment. The temperature recorded inside the house was 34 °C for the 1st and the 2nd days, 32 °C for the 3rd and 4th days, 30 °C for the 5th-7th days, 29 °C for the 2nd week, 26 °C for the 3rd week, and 15 °C from the

22nd day to the 42nd day, for the control group. All the temperatures were the same for the trial group, except for the cold conditioning period, which was 15 °C for the 5th and 6th days, and average humidity was 68% inside the house. On the 21st day, the temperature in the experimental house was abruptly decreased to 15 °C (\pm 2 °C) and maintained until the end of the experiment.

Body weight and feed intake were recorded at weekly intervals, both on an individual and group basis. Maximum/minimum temperatures and humidity were determined every 12 h, at midday and midnight, by means of maximum-minimum thermometers and hygrometers. Mortality was recorded daily. A one-sided alternative hypothesis was built concerning mortality. Birds were slaughtered at 42 days of age. From each treatment group, 35 hot carcasses were weighed. These carcasses were kept in cold storage at -18 °C for 1 h and cold carcass weights were obtained. Cold carcasses were first weighed whole and then cut into pieces and weighed individually, as back quarter (pelvis, femur, and tibia/fibula included), breast (back bone and keel included), wings, and neck. Data relating to live weight and carcass traits were analyzed using the independent t-test of the SPSS program (8). The mortality rate was also analyzed by means of the Mann-Whitney U test (8). Means were considered significantly different at $P < 0.05$.

Results

Mean body weight, feed consumption, and feed conversion ratio (FCR) of the control and cold-conditioned chickens were 2475.9 \pm 36.1 g and 2413.7 \pm 30.2 g, 1470.2 \pm 34.7 g and 1443.3 \pm 37.2 g, and 1.95 \pm 3.3 and 1.92 \pm 2.9, respectively (Table 1). No significant differences were observed between the groups.

Mean weight of hot carcasses, cold carcasses, back quarters, breasts, wings, and necks of control and cold-conditioned chickens were 1684.4 \pm 17.9 g and 1649.3 \pm 18.1 g, 1659.8 \pm 17.9 g and 1622.9 \pm 17.8 g, 1059.7 \pm 10.5 g and 1012.4 \pm 8.0 g, 1021.6 \pm 7.0 g and 1021.4 \pm 7.9 g, 315.4 \pm 2.9 g and 304.7 \pm 2.1 g, and 88.1 \pm 1.7 g and 84.8 \pm 2.2 g, respectively (Table 2). No significant differences were observed between the groups.

Table 1. Weekly mean body weights, feed consumption, and feed conversion ratio (FCR) of the control and cold-conditioned male broiler chickens up to 42 days of age (Mean \pm SE).

Weeks	Body weight (g/week)			Feed consumption (g/week)			Feed conversion ratio (g feed/g gain)		
	Control group	Cold-conditioned group	P	Control group	Cold-conditioned group	P	Control group	Cold-conditioned group	P
1	176.5 \pm 4.3	165.1 \pm 3.3	1.48	201.9 \pm 4.6	181.3 \pm 4.7	3.12	1.50 \pm 3.1	1.47 \pm 2.3	0.44
2	377.6 \pm 11.5	364.5 \pm 6.2	0.41	396.4 \pm 11.2	375.1 \pm 5.4	1.70	1.97 \pm 0.2	1.88 \pm 4.2	0.71
3	689.3 \pm 13.4	674.9 \pm 8.8	0.54	631.9 \pm 14.2	602.3 \pm 13.5	1.52	2.02 \pm 3.4	1.94 \pm 5.3	0.47
4	1182.7 \pm 21.4	1148.5 \pm 15.8	0.31	942.4 \pm 27.5	907.1 \pm 20.8	0.97	1.91 \pm 4.1	1.84 \pm 3.9	0.12
5	1724.4 \pm 33.6	1672.8 \pm 25.3	0.31	1142.0 \pm 23.3	1074.5 \pm 18.1	2.29	2.11 \pm 5.6	2.05 \pm 2.7	0.64
6	2475.9 \pm 36.1	2423.7 \pm 30.2	0.30	1470.2 \pm 34.7	1443.3 \pm 37.2	1.76	1.95 \pm 3.3	1.92 \pm 2.9	0.53

SE: standard error; P: t-test

Table 2. Weights of male broiler carcasses and carcass sections (g) of the control and cold-conditioned groups.

	Control group		Cold conditioned group		P
	Mean	SE	Mean	SE	
Hot carcass (g)	1684.4	17.9	1649.3	18.1	1.57
Cold carcass (g)	1659.8	17.9	1622.9	17.8	1.51
Back quarter (g)	1059.7	10.5	1012.4	8.0	1.69
Breast (g)	1021.6	7.0	1021.4	7.9	0.53
Wing (g)	315.4	2.9	304.7	2.1	1.94
Neck (g)	88.1	1.7	84.8	2.2	0.59

SE: standard error; P: t-test

Mean yield percentages for hot carcasses, cold carcasses, back quarters, breasts, wings and necks of control and cold-conditioned chickens were 68.03 ± 1.01 and 68.05 ± 1.31 , 67.04 ± 1.01 and 66.96 ± 1.31 , 42.28 ± 0.96 and 41.77 ± 0.23 , 41.26 ± 0.36 and 42.14 ± 0.33 , 12.74 ± 0.15 and 12.57 ± 0.12 , and 3.56 ± 0.15 and 3.50 ± 0.17 , respectively (Table 3). No significant differences were observed between the groups.

The mortality rates for the control and cold-conditioned chickens were 11% and 5%, respectively (Table 4). The difference between the mortality rates was statistically significant ($P < 0.05$).

Discussion

The fact that cold conditioning did not significantly affect body weight gain in broilers may suggest an enhancement in the capacity of the conditioned chicks to cope with the effects of acute cold exposure (Table 1). This finding is supported by the observations of several other researchers.

Shinder et al. (3) exposed 240 broiler chicks to 15 °C ambient temperature for 3 h on the third and fourth days of age. They then divided the chicks into 2 groups (control and trial) and applied 15 and 22 °C of ambient temperature to each group from the 21st day to slaughter. Body weights at 49 days of age of the control

Table 3. Carcass yields (%) of the control and cold-conditioned male broiler chickens.

	Control group		Cold conditioned group		P
	Mean	SE	Mean	SE	
Yield I (with hot carcass)	68.03	1.01	68.05	1.31	0.01
Yield II (with cold carcass)	67.04	1.01	66.96	1.31	0.04
Back quarter yield	42.28	0.96	41.77	0.23	0.521
Breast yield	41.26	0.36	42.14	0.33	0.104
Wing yield	12.74	0.15	12.57	0.12	0.406
Neck yield	3.56	0.15	3.50	0.17	0.628

SE: standard error; P: t-test

Table 4. Mortality rates of the control and cold-conditioned broiler chickens.

Weeks	Mortality (%)		P
	Control group	Cold-conditioned group	
	Dead bird number	Dead bird number	
Week – 1	0	0	
Week – 2	3	2	
Week – 3	5	3	
Week – 4	7	2	0.16
Week – 5	8	3	
Week – 6	10	3	
Total mortality	33	13	
Mortality percentage (%)	11	5	

P < 0.05, P: Mann-Whitney U test

and trial groups were 2712 ± 72 g and 2795 ± 35 g, respectively. There was no significant difference in mean body weight between the groups.

Similarly, Bottje et al. (9) divided 100 male broiler chickens into 2 groups, namely control and cold-stressed group, and kept them in 32 and 29 °C, respectively, for the first 2 weeks. The ambient temperature for the control group was reduced to 27 °C for week 3, and 23 °C for weeks 4 to 7, while for the cold chamber group it was reduced to 18 °C for week 3 and maintained at 15-18 °C from week 4 onwards. Body weights for control and cold-conditioned groups at 7 weeks were 3164 ± 67 g and 3209 ± 15 g, respectively. There was no significant difference in mean body weight between the groups.

The difference in FCR of the control (1.95) and cold-conditioned groups (1.92) was not significant since there was no difference in live weight and feed consumption. The FCR was in accordance with commercial practices (Table 1). In this study the chicks in the cold-conditioned group huddled together and stopped eating as they reduced their movement during the cold conditioning during the early stage of life. Birds in the cold-conditioned group always consumed less feed throughout the growing period compared to the controls; however, there was no significant difference in feed consumption or FCR.

The weight of hot carcasses (1684.4 ± 17.9 g in the control and 1649.3 ± 18.1 g in the cold-conditioned group), cold carcass (1659.8 ± 17.9 g in the control and

1622.9 ± 17.8 g in cold-conditioned group), back quarter (1059.7 ± 10.5 g in the control and 1012.4 ± 8.0 g in the cold-conditioned group), breast (1021.6 ± 7.0 g in the control and 1021.4 ± 7.9 g in the cold-conditioned group), wing (315.4 ± 2.9 g in the control and 304.7 g ± 2.1 g in the cold-conditioned group), and neck (88.1 g ± 1.7 g in the control and 84.8 ± 2.2 g in the cold-conditioned group) followed a similar trend as the live weight, with a slight difference in favor of the control group, but the difference was not significant (Table 2). There were no matching results reported in the literature regarding carcass and carcass parts of broilers grown under conventional and cold conditions. Since the difference between the control and the cold-conditioned groups was not significant in the present experiment, it can be concluded that the short-term cold conditioning during the early stage of life did not detrimentally affect body weight, carcass weight, or the weight of several carcass parts. In this experiment there were always small but insignificant differences between the live, carcass, and carcass parts weights in favor of the control group, except the weight of breast muscles. Breast muscles in the 2 groups were the same (1021.6 g in the control group and 1021.4 g in the cold-conditioned group). This may be regarded as an interesting result considering the chicken meat marketing in which the breast muscle has the best monetary value worldwide.

The percentage yield of hot carcass (68.03 ± 1.01 in the control and 68.05 ± 1.31 in the cold-conditioned group), cold carcass (67.04 ± 1.01 in the control and 66.96 ± 1.31 in the cold-conditioned group), back quarter (42.28 ± 0.96 in the control and 41.77 ± 0.23 in the cold-conditioned group), breast (41.26 ± 0.36 in the control and 42.14 ± 0.33 in the cold-conditioned group), wing (12.74 ± 0.15 in the control and 12.57 ± 0.12 in the cold-conditioned group), and neck (3.56 ± 0.15 in control and 3.50 ± 0.17 in the cold-conditioned group) were also similar to the trend of the weight of carcasses and carcass parts and were in accordance with commercial practices (Table 3).

The difference in the mortality rate of the control (11%) and the cold-conditioned group (5%) was significantly different ($P < 0.05$). The cold-conditioned

group performed nearly 100% better than the control group, regarding mortality (Table 4). No mortality was observed during the first week of the treatment. Some mortality was seen from the second week onward. In particular, the weekly mortality figures for the control group became significantly higher compared to the cold-conditioned group starting from the third week onwards. The main cause of death was the rapid change in ambient temperature. Similarly, Shinder et al. (3) found a significant difference between groups when an ambient temperature of 15 °C was maintained after the third week. Mortality in the cold-conditioned group was 13% compared to 23% in the control group, representing a 100% higher mortality rate. The significant mortality difference between the groups could be an indicator of the sensitivity of the chicks to the fluctuating ambient temperature. Reducing mortality without any trade-off in yields could be an important benefit for growers as well.

The findings of this study suggest that early age (days 5 and 6) cold conditioning had no detrimental effect on growth or other parameters of broiler chickens in later ages. It also suggests that cold conditioning assisted in reducing any detrimental effects on later age mortality resulting from fluctuating temperatures in the broiler house. This improvement is considered to be a result of the improved thermo-tolerance of the chicks, which resulted from the application of cold conditioning at early ages. This procedure may be beneficial for those houses that have poor insulation in winter months. Cold conditioning at an early age can induce cold-stress resistance in chicks at a later age.

It seems that acclimatization was a strong thermoregulatory process, although cold conditioning by itself improves the ability to cope with cold stress, as was demonstrated by the low mortality rate among the conditioned birds.

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References

1. Yahav, S., Hurwitz, S.: Induction of thermotolerance in male broiler chickens by temperature conditioning at an early age. *Poult. Sci.*, 1996; 75: 402-406.
2. Decuypere, E., Tona, K., Bruggeman, V., Bamelis, F.: The day-old chick: a crucial hinge between breeders and broilers. *World's Poult. Sci. J.*, 2001; 57: 127-138.
3. Shinder, D., Luger, D., Rusal, M., Rzepakovsky, V., Bresler, V., Yahav, S.: Early age cold conditioning in broiler chickens (*Gallus domesticus*): thermotolerance and growth responses. *J. Therm. Biol.*, 2002; 27: 517-523.
4. Nichelmann, M., Janke, O., Tzschentke, B.: Efficiency of thermoregulation in precocial avian species during the prenatal period. *J. Therm. Biol.*, 2001; 26: 273-280.
5. Nichelmann, M., Tzschentke, B., Tonhardt, H.: Perinatal development of control systems in birds. *Comp. Biochem. Physiol. A, Mol. Integr. Physiol.*, 2002; 131: 697-699.
6. Wekstein, D.R., Zolman, J.F.: Cold stress regulation in young chickens. *Poult. Sci.*, 1971; 50: 56-61.
7. Collin, A., Buyse, J., Van As, P., Darras, V.M., Malheiros, R.D., Moraes, V.M., Reyns, G.E., Taouis, M., Decuypere, E.: Cold-induced enhancement of avian uncoupling protein expression, heat production and triiodothyronine concentrations in broiler chicks. *Gen. Comp. Endocrinol.*, 2003; 130: 70-77.
8. SPSS Inc.: SPSS for windows 11.0 Base system user's guide, release 11.0 SPSS Inc. Chicago, 2002.
9. Bottje, W.G., Wang, S., Beers, K.W., Cawthon, D.: Lung lining fluid antioxidants in male broilers: age-related changes under thermoneutral and cold temperature conditions. *Poult. Sci.*, 1998; 77: 1905-1912.