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Effects of Heat Stress on Some Blood Parameters in Broilers

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Abstract: The purpose of the present study was to determine the effects of acute heat stress on the proportions of leucocyte components and hematocrit values in broiler chickens.

Exposure of broiler chickens to 39 ± 1 °C for 2 h at 44 d of age caused an increase in rectal temperatures, and in heterophil and basophil ratios. The H/L ratio also increased from 0.25 to 0.43.

The exposure of the broilers to acute heat stress resulted in decreased monocyte and lymphocyte proportions whereas the proportion of eosinophil and the hematocrit values were not affected.

It was concluded that a temperature high enough to cause increased body temperature also changes circulating leucocyte components in broilers.

Key Words: Heat stress, broiler, blood parameters, H/L ratio, leucocyte components.

Etlık Piliçlerde Sıcak Stresinin Bazı Kan Parametreleri Üzerine Etkileri

Özet: Bu çalışmanın amacı etlik piliçlerde akut sıcak stresinin hemotokrit değerleri ve lökosit komponentlerinin oranları üzerine etkisini saptamaktır.

Etlık piliçlerin 44 gün yaşında 2 saat süreyle 39 ± 1 C° sıcak stresine maruz kalmaları rektal sıcaklık, heterofil ve bazofil oranlarında artışa neden olmuştur.

Etlık piliçlerin akut sıcak stresine maruz kalmaları monosit ve lenfosit oranlarında azalmaya sebep olurken, eosinofil ve hemotokrit değerleri etkilenmemiştir.

Etlık piliçlerde vücut sıcaklığının artmasına neden olacak kadar yüksek çevre sıcaklığının lökosit komponentlerini de değiştireceği sonucuna varılmıştır.

While the effect of genotype on lamb birth weight was significant ($P<0.01$), it had no significant on the other characteristics. Birth type had a significant ($P<0.01$) effect on lamb weight gain in different periods, but the effect of sex was not significant.

Anahtar Sözcükler: Sıcak stresi, etlik piliç, kan parametreleri, H/L oranı, lökosit komponentleri.

Introduction

Corticosteroid concentrations in blood have been used as a measure of environmental stress in birds (1, 2, 3, 4). In addition, the relationship between adrenocorticotrophic hormone (ACTH) and leucocyte response has been widely examined. It has been reported that when ACTH is administered either by injection (5, 6) or in feed (7), the proportions of leucocyte components change significantly. Chicken leucocyte changes in response to stress have been found to be less variable and thus a more reliable indicator than plasma corticosterone values (8, 9). In several studies, it has been determined that psychological and physical stressors such as fasting, frustration, water deprivation and crowding, increase the ratio of Heterophil to Lymphocyte (H/L) (4, 10, 11, 12, 13).

The H/L ratio has been shown to be highly heritable (14) and a reliable index for determining stress in poultry (8).

However, Gross and Siegel (15) demonstrated that H/L ratios increased after initial fasting, but only a small increase was determined after repeated fasting. Other researchers (16, 17, 18) have also noted similar responses, suggesting that chickens are able to adapt to the stress of prolonged food restriction.

Food restriction has also been shown to produce significant basophilia in broilers (17, 18).

Leucocytic responses have been used as an indicator of heat or cold stress in poultry. Heat stress has been found to decrease lymphocyte numbers and increase plasma

corticosterone levels in cockerels (19). Wolford and Ringer (5) observed an increase in lymphocytes when hens were exposed to cold (0 °F) for 15 h without feed and water. Similarly, Gross (20) determined that, following exposure to 6 °C for 30 min, the H/L ratio increased to peak values, and 1 day after cold stress this ratio returned to pre-exposure levels.

McFarlane and Curtis (9) subjected broiler chicks to multiple concurrent stressors; ammonia, coccidiosis, electric shock, heat stress, and noise, and discovered that the H/L ratio was increased by electric shock, heat stress and ammonia treatment.

When broilers were exposed to heat stress generated during road transportation, basophil counts significantly increased (21). Basophil degranulation was observed in these heat-stressed broilers (22).

Hematocrit values also vary with the ambient temperature at which birds are reared. The exposure of chickens to high temperatures causes a decrease in blood hematocrit values (23, 24, 25, 26, 27).

The purpose of the present study was to determine the effects of acute heat stress on the proportions of leucocyte components, the H/L ratio and hematocrit values in broiler chickens.

Material and Method

A total of 40 Cobb broiler chicks were used. These were kept in individual cages under 23 h light/day. From hatching to 42 d, the chicks were raised according to a typical commercial management program. Feed and water was provided for ad-libitum consumption. At 42 d, the rectal temperatures of all the chickens were recorded. Then, blood from the branchial vein was taken from each hen for blood analysis. Two days later, the chickens were exposed to 39±1 °C for 2 h. Rectal temperatures were measured and blood samples were taken at the end of the heat stress period.

Blood samples for hematocrit were collected in heparinized capillary tubes and centrifuged in a micro hematocrit centrifuge for 7 min.

In the differential leucocyte counts, two drops of blood were collected from the branchial vein, and blood smears were made on duplicate glass slides. These smears were stained with Wright stain in 15 min.

One hundred leucocytes, including heterophils, lymphocytes, monocytes, basophils and eosinophils were counted on each slide. The H/L ratio was calculated by dividing the number of heterophils by the number of

lymphocytes. Both slides were counted and the means were calculated for each bird.

Data were analyzed by one-way ANOVA using GLM of SAS (28) to determine the effect of acute heat stress on blood parameters and rectal temperatures.

The use of percentage data transformed by arcsin did not change the results, so the analyses of untransformed data are reported here.

Results

The effects of acute heat stress on rectal temperature, hematocrit value and the proportion of different subtypes of leucocyte are presented in Table 1. Exposure of the broilers to 39 °C significantly increased rectal temperatures, heterophil and basophil proportions and H/L ratios, and decreased monocyte and lymphocyte proportions. It was determined that acute heat stress did not affect the hematocrit values or eosinophil proportion.

Discussion

Exposure of the broilers to a high temperature for 2 h increased rectal temperatures. This result is in agreement with the reports of other researchers (26, 29, 30), who observed that body temperature increased during heat stress. Exposure of the broiler chickens to 39 °C for 2 h did not affect the hematocrit value.

Acute heat stress caused changes in the proportions of circulating leucocyte components.

After 2 h heat stress, the broiler chickens exhibited significantly reduced lymphocyte and raised heterophil ratios. As a consequence, the H/L ratio increased from 0.25 to 0.43.

Acute heat-stressed broilers responded with a significant increase in basophilias. This finding is in agreement with the findings of Mitchell et al. (21) and Maxwell et al. (22), who observed an increase in basophil counts after heat stress.

Maxwell et al. (22) and Maxwell (32) suggested that an increase in the H/L ratio may be a response to mild or moderate stress but a basophilia may result from extreme stress, such as life-threatening situations.

Although the H/L ratio of 0.43 shows optimum stress according to Gross and Siegel (8), basophilia observed in this study show that exposure of the broiler chickens at 39 °C for 2 h at 44 d produced significant heat stress effects in these birds.

It has been reported that during conditions of extreme stress, when a heteropenia and basophilia may develop, the H/L ratio cannot be used as a reliable measurement of stress (32, 33).

Exposure of the broilers to acute heat stress resulted in a decreased monocyte proportion whereas the eosinophil proportion was not affected (Table 1).

Maxwell et al. (31) found that broilers given limited feed showed only a small decrease in eosinophil and monocyte numbers. In the review of Maxwell and Robertson (33), it was reported that eosinophils disappear from circulation and basophils increase in circulation during stress, particularly acute stress.

It is concluded that a temperature high enough to cause increased body temperature also changes circulating leucocyte components in chickens.

	Unexposed	Exposed
Rectal Temperature, °C	40.715±0.089a	42.011±0.089b
Lymphocyte, %	73.553±0.919a	62.787±0.919b
Heterophil, %	17.468±0.761a	26.468±0.761b
Eosinophil, %	3.660±0.196a	3.532±0.196a
Basophil, %	2.340±0.296a	5.468±0.296b
Monocyte, %	2.894±0.226a	2.000±0.226b
H / L Ratio	0.246±0.016a	0.434±0.016b
Hematocrit, %	34.091±0.699a	32.750±0.819a

Table 1. Effects of acute heat stress on rectal temperature, hematocrit value, differential leucocyte counts and H / L ratios ($\bar{X} \pm S\bar{x}$).

^{a,b}Means in row with no common superscript differ significantly (p<0.05).

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