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Physiological Dynamic of Broiler at Various Environmental Temperatures

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Abstract: This experiment was conducted to evaluate the effect of various environmental temperatures and time of sampling on physiological dynamic of broilers. The effect of treatment on level of triiodothyronine hormone (T3), cholesterol, glucose and protein plasma as well as the weight of bursa of Fabricius and spleen in broilers was also estimated. One hundred and fourty 14-d old broilers with 500-600 g of body weight were used as materials. The treatments had two factors, the first factors were consisted of five experiment temperatures (25.55±1.45 with feeding *ad libitum*; 25.55±1.45 with pair feeding as T2; 25.55±1.45 with pair feeding as T3; 29.29±1.27 with feeding *ad libitum* and 31.59±1.05°C with feeding *ad libitum* as T1, T1FP1, T1FP2, T2A and T3A respectively) and the second factors were three times of sampling (4, 8 and 16 days after factor of experiment temperature as D4, D8 and D16 respectively). 5 x 3 split plot experimental design was used to analyze the data (five experiment temperatures and three times of sampling). Data collected were analyzed with Analysis of Variance (ANOVA) and Duncan Multiple Range Test (DMRT) was further used to test the significant differences. The experiment resulted that T3 level of T1FP1, T1FP2, T2A and T3A, lower than T1A, meanwhile of D16 and D8 were higher than D4. The cholesterol of T1A was lower than others. Level of glucose of T1A was lower than others too. The weight of bursa of Fabricius of T1A, T1PF1, T1PF2, were higher than T2A and T3A. The weight of spleen of D16 was higher than D8 and D4.

Key words: Environmental temperature, triiodothyronine, cholesterol, lymphoid organ

INTRODUCTION

High environmental temperature may result in the accumulation of body heat load so that the body suffers from heat stress. As one of the homeothermic species, poultry (broiler) could maintain their body temperature relatively constant by increasing water consumption and decrease feed consumption. As a result, their growth rate and productivity will decrease.

Lu *et al.* (2007) reported that feed consumption and body weight gain of broilers reared at temperature of 21°C (from 5-8 weeks of age) were 169.9 g/d and 61.45 g/d respectively, significantly higher than for those reared at 34°C with feed consumption and body weigh gain of 93.6 g/d and 22.29 g/d. respectively. However, feed to gain ratio increased from 2.76 at low temperature to 3.92 at high of temperature. The resemble result showed by Roussan *et al.* (2008).

Sugito *et al.* (2007) and Kusnadi and Rahim (2009) approved from their experiments that heat stress could reduce growth rate as well as level of the hormone triiodothyronine (T3) in blood plasma of broiler chicken. As calorigenic factor T3 has the function to increase oxygen consumption for metabolisms through what the increment of growth rate could be gained.

Puvadolpirod and Thaxton (2000) showed, that administration of Adrenocorticortiotropin Hormone (ACTH) as artificial stress (16 IU/kg BW) during 7 days, significantly decreased body weigh gain at 8th and 16th day. However, this treatment significantly increased the plasma glucose level, protein and corticosterone hormone at 4th and 8th day.

Sunder *et al.* (2008) summarized their experimental research that energy restriction regimes reduced the weight of bursa of Fabricius and spleen of broiler chicken. The ration with low arginine content in broiler chicken reduced feed consumption and body weight gain as well as the weights of thymus, bursa of Fabricius and spleen broiler (Kwak *et al.*, 1999). Bursa of Fabricius, spleen and thymus belong to lymphoid organs those have function to produce lymphocyte. Meanwhile, lymphocyte belongs to leucocyte which has function in producing immunoglobulin (Ig) like Ig A, Ig Y, Ig G and Ig M (Swenson, 1993).

Therefore, the objective of this research was to find out the effect of various environmental temperatures and time of sampling on physiological dynamic of broilers.

MATERIALS AND METHODS

One hundred and fourty 14-d old broilers with 500-600 g of body weights were used as samples. The treatments had two factors, the first factors were five experiment temperatures (25.55±1.45 with feeding *ad libitum*; 25.55±1.45 with pair feeding as T2; 25.55±1.45 with pair feeding as T3; 29.29±1.27 with feeding *ad libitum* and 31.59±1.05°C with feeding *ad libitum* as T1, T1FP1, T1FP2, T2A and T3A respectively) and the second

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factors were three times of sampling (4, 8 and 16 days after factor of experiment temperature as D4, D8 and D16 respectively). The fair feeding of T1FP1 and T1FP2 were measured of the day before from feed consumption of T2A and T3A respectively. The ration used was commercial feeding from commercial industry. The drinking water was always available or *ad libitum*.

The measured variables consisted of plasma triiodothyronine (T3) hormone level, measured with ELISA methods, cholesterol total, glucose and protein of plasma. All of them were measured with clinical chemistry Auto Analyzer used spectrophotometer. Relative Bursa of Fabricius and spleen weight were measured by weighing that organs (g) and dividing with kg of Body Weight (BW).

The experimental design used was a completely randomized design in split plot 5 x 3 (five experiment temperatures and three times of sampling) with four replications, respectively. Data collected were analyzed with Analysis of Variance (ANOVA) and Duncan Multiple Range Test (DMRT) was further used to test the significant differences (Steel and Torrie, 1993).

RESULTS AND DISCUSSION

Analysis of variance resulted that interactions of experiment temperature x time of sampling did not affect significantly on T3 level, cholesterol, glucose, protein plasma, relative bursa of Fabricius and spleen weight. Experiment temperature affected significantly ($p<0.05$) on T3, cholesterol and glucose level. Time of sampling affected significantly ($p<0.05$) on T3 and glucose level. The average of T3, cholesterol, glucose and protein were shown in Table 1 and the average of bursa of Fabricius and spleen were shown in Table 2.

Table 1: Effect of experimental temperature and time of sampling on thryiodotironine (T3), total cholesterol, glucose and protein of plasma

Experiment temperature	Time of sampling (days) D4	D8	D16	Average
T3 (ng/mL)				
T1A	0.645	1.600	2.780	1.675^{d}
T1FP1	0.304	1.250	2.500	1.351^{c}
T1FP2	0.540	1.010	2.780	1.443^{c}
T2A	0.595	0.970	0.990	0.852^{b}
T3A	0.440	0.200	0.280	0.307^{a}
Average	0.505^{A}	1.006^{B}	1.866^{C}	
Total cholesterol (mg/dL)				
T1A	125.0	103.5	109.0	112.5^{a}
T1FP1	126.5	153.5	128.5	136.2^{b}
T1FP2	124.5	142.5	136.0	134.3^{b}
T2A	134.5	122.0	135.0	130.5^{b}
T3A	147.0	143.5	129.0	139.8^{b}
Average	131.5	133.0	127.5	
Glucose (mg/dL)				
T1A	131.0	110.0	109.0	116.7^{a}
T1FP1	185.0	214.5	128.5	176.0^{b}
T1FP2	213.5	239.0	136.0	196.2^{c}
T2A	226.5	225.5	135.0	195.7^{c}
T3A	221.5	228.5	129.0	193.0^{c}
Average	195.5^{B}	203.5^{B}	127.5^{A}	
Protein (g/dL)				
T1A	3.020	2.685	2.660	2.788
T1FP1	2.830	2.825	2.495	2.7166
T1FP2	2.765	3.350	2.665	2.927
T2A	2.975	2.805	2.870	2.883
T3A	3.310	2.775	2.855	2.980
Average	2.980	2.888	2.709	

$^{a-b}$Means with different superscripts within the same column differ significantly ($p<0.05$).

$^{A-B}$Means with different superscripts within the same row differ significantly ($p<0.05$). T1A = Experiment temperature at 25.55±1.45 with feeding *ad libitum*; T1FP1 = Experiment temperature at 25.55±1.45 with fair feeding as T2A, T1FP2 = Experiment temperature at 25.55±1.45 with fair feeding as T3A, T2A = Experiment temperature at 29.29±1.27 with feeding *ad libitum* and T3A = Experiment temperature at 31.59±1.05°C with feeding *ad libitum*

Effect of experimental temperature and time of sampling on thryiodotironine (T3), cholesterol, glucose and protein of plasma: Table 1 showed that average of T3 in T1A was 1.675 ng/ml. It was significantly higher than in T1FP1, T1FP2, T2A and T3A (1.351; 1.443; 0.852 and 0.307 ng/mL respectively). The decreasing of T3 in T2A, T3A and in T1FP1 and TIFP2, it could be possible, because T3 hormone was calorigenic hormone that will decrease at high environmental temperature and in low nutrition status (Decuypere and Buyse, 2005), administration of methimazole (Lin *et al*., 2008), treatment by feeding withdrawal, catching and transport (Nijdam *et al*., 2005). In addition, the average of T3 in D4 was 0.505 ng/mL and was significantly lower than in D8 and in D16 (1.006 and 1.866 ng/mL respectively). This is because, T3 hormone level has positive correlation with age and growth (Lu *et al*., 2007).

Furthermore, Table 1 showed that the level of total plasma cholesterol of T1A was 112.5 mg/dL. It was significantly lower ($p<0.05$) than T1PF1, T1PF2, T2A and T3A (136.2, 134.3, 130.5 and 139.8 mg/dL respectively). These results indicated that the increasing of total cholesterol occurred at high environmental temperature and with fair feeding. Because, at high environmental temperature, oxidation of cholesterol occurred especially in LDL cholesterol, so total cholesterol would increase. These results agree with the findings of Puvadolpirod and Thaxton (2000), Post *et al*. (2003) and Olanrewaju *et al*. (2007) who reported that artificial stress with ACTH administration, significantly increased the total cholesterol level of broilers.

The level of plasma glucose of T1A was 112.5 mg/dL, it was significantly lower than T1FP1, T1FP2, T2A and T3A (176.0, 196.2, 195.7 and 193.0 mg/dL respectively). Meanwhile, the plasma glucose of D16 was 127.5 mg/dL, significantly lower than D8 and D4 (203.5 and 195.5 mg/dL respectively). The increasing of glucose at

Table 2: Effect of experimental temperature and time of sampling on bursa of Fabricius and spleen

Experiment temperature	Time of sampling (days) 4	8	16	Average
Bursa of fabricius (g/kg BW)				
T1A	2.713	1.973	2.412	2.366[b]
T1FP1	1.898	2.601	2.360	2.286[b]
T1FP2	2.009	2.546	2.606	2.387[b]
T2A	2.022	1.928	1.782	1.911[a]
T3A	2.202	2.009	1.449	1.887[a]
Average	2.169	2.211	2.122	
Spleen (g/kg BW)				
T1A	0.930	0.818	0.703	0.817
T1FP1	0.617	0.705	0.791	0.704
T1FP2	0.585	0.596	0.921	0.700
T2A	0.499	0.563	1.118	0.727
T3A	0.662	0.639	0.970	0.757
Average	0.659[a]	0.664[b]	0.901[c]	

[a-b]Means with different superscripts within the same raw/column differ significantly ($p<0.05$). T1A = Experiment temperature at 25.55±1.45 with feeding *ad libitum*; T1FP1 = Experiment temperature at 25.55±1.45 with fair feeding as T2A, T1FP2 = Experiment temperature at 25.55±1.45 with fair feeding as T3A, T2A = Experiment temperature at 29.29±1.27 with feeding *ad libitum* and T3A = Experiment temperature at 31.59±1.05°C with feeding *ad libitum*

high environmental temperature, was due to gluconeogenesis process that occurred from lipid (not from protein). This result agree with the findings of Bedanova *et al*. (2007) who reported that shackling increased the level of glucose, corticosterone hormone and lactate of broilers.

Effect of experimental temperature and time of sampling on bursa of Fabricius and spleen: Table 2, showed that the average weights of bursa of Fabricius of T1A, T1PF1 and T1PF2 were 2.366, 2.286 and 2.387 g/kg BW respectively. These were significantly ($p<0.05$) higher than T2A and T3A (1.911 and 1.887 g/kg BW). This is indicated that weight of bursa of Fabricius as a lymphoid organ, will decrease at high environmental temperature. These results are in agreement with Puvadolpirod and Thaxton (2000) who reported that artificial stress with ACTH and corticosterone administration, decreased the bursa of Fabricius and spleen. Heckert *et al*. (2002) also confirmed that higher density of broilers in a cage, significantly ($p<0.05$) decreased the bursa and spleen. Furthermore, Table 2 showed that the average of spleen weight at D4 was 0.569 g/kg BW, it was significantly ($p<0.05$) lower than D8 and D16 (0.664 and 0.910 g/kg BW respectively). This could be understood, because the spleen is a lymphoid organ (lymphocyte producer) which will increase relatively in older age. Yunianto *et al*. (1997) reported that heat stress in animal stimulated the increment of plasma corticosterone hormone. Siegel (1995) found that corticosterone eliminated growth of lymphoid organs (bursa of Fabricius and spleen). It could lead into the disturbances of immune system production in the body and reduction in growth rate of the animal. Reduction of growth rate and low amount of lymphocyte which were due to the corticosterone increment in blood plasma approved by several researchers like Kusnadi (2004); Kusnadi *et al*. (2005); Onbasilar *et al*. (2008) and Zulkifli *et al*. (2000).

Conclusion: It could be summarized that high environmental temperature and pair feeding, both decreased T3 level and weight of bursa of Fabricius, however both increased the cholesterol and glucose. Time of sampling increased the T3 level and weight of spleen.

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