Measuring the Responses of Different Genotypes of Slow Growing Broilers Toward Short-Term Heat Challenge Test

R. Afnan[1] and M. Gerken[2]
[1] Department of Animal Production and Technology, Bogor Agricultural University, Bogor, Indonesia
[2] Department of Ecology of Animal Farming and Behaviour, Georg August University, Goettingen, Germany

ABSTRACT

This study was performed to evaluate the responds of different genotype of slow growing broilers with regard to heat stress. A number of 102 females from the slow growing broiler hybrids (Hubbard ISA I657, S757N and I957) were raised from hatch until week 5 in 3 pens under the same room temperature of 30°C beginning from week 3 until 5. Twenty four experimental birds of each genotype were individually exposed for 15 minutes to a short-term heat test at 30°C (control) and 35°C between weeks 3, 4, and 5. The rectal temperatures before and after heat exposure were measured and the latency until panting was recorded. Strain differences were significant for body weight, daily weight gain and relative growth rate (P<0.01). For I657, S757N and I957, respectively, body weight in week 5 averaged 815.8±81.2, 924.0±87.9 and 1269.3±136.3 g. Daily gain averaged 22.0±9.8, 25.5±13.1 and 34.9±17.6 g/d, whereas relative growth rate ranged between 11.5±5.5, 13.9±6.9 and 13.0±6.1 %. Rectal temperatures after short-term heat stress were 42.4±0.7°C, 42.4±0.7°C and 42.7±0.7°C, with strains differing significantly (P<0.01). The level of heat stress temperature significantly influenced latency until panting (P<0.01). When exposed to 35°C, birds started panting within 10.95±2.43 (I657), 12.26±2.61 (S757N) and 10.16±2.36 (I957) minutes. The chi-square analyses revealed significant influences of the heat level and the strain on the frequency of birds panting (P<0.01). After 35°C test, 96% (I657), 100% (I957) and 67% (S757N) of birds demonstrated panting (P<0.01), while strain differences were not significant for frequency of birds panting exposed to 30°C.

Key words: slow growing broilers, short-term heat stress, rectal temperatures, panting, growth

INTRODUCTION

Heat stress is one of the important stress factors especially in tropical and subtropical environments which affected the productive performance of broilers. High mortality decreased feed consumption and poor body weight gain as disadvantages have been reported by many authors. Beside high ambient temperature, the large contribution to heat production occurs in the bird itself since metabolic production increases as the body weight of bird progresses (Lott *et al*., 1998).

Under hot environment, heat production decrease whereas heat dissipation increase. When air temperature climbs, the breathing frequency of birds increases and the evaporative heat loss enhances significantly (Wiernuz and Teeter, 1996) and dissipated through respiratory evaporation as the main avenue (Hillman *et al*., 1985).

Increased heat tolerance is reflected in lower body temperature and the limit of temperature tolerance is affected by body weight. Sykes and Fataftah (1986) reported the index of heat tolerance is the increasing rate of rectal temperature from the start and after one hour of exposure. Value of 2^{o}C/h or more reflects rapidly rising body temperature meanwhile, value of ≤0.5^{o}C/h indicates effective heat tolerance.

The intensive genetic selection for rapid growth rate has been associated with increased susceptibility of broilers to heat stress. Birds selected for rapid growth demonstrate higher body temperature (low heat tolerance) compared to slow growing birds which have a greater tolerance to high temperatures (Cahaner and Leenstra, 1992, Berong and Washburn, 1998).

The present experiment was conducted to develop a suitable method to measure reactions of slow growing broilers towards heat stress and to evaluate the differences between three genotypes of commercial slow growing broiler hybrids with regard to heat stress reactions.

MATERIALS AND METHODS

A total of 102 day old chicks from 3 commercial broiler hybrids (Hubbard ISA, France) differing in growth patterns hatched were imported from France. Genotypes used were I657 (slow growth, red), S757N (slow growth, Nn) and I957 (medium slow, white). All chicks hatched in the same hatchery on the same day and sexed and only females were used from hatch until 5 weeks of age. Birds were wing banded and housed in the same room in 3 pens (measuring 6.40 m^2/pen) having 34 chicks in each (stocking density of 5.3 birds/m^2) with strains separated. The ambient temperature was maintained at 30°C in week 3 until the end of the experiment. Birds were fed *ad libitum* with starter crumble diet (22.76% CP and 11.92 MJ/kg ME) during the first 3 weeks and a 2 mm grower pellets diet (19.67% CP and 12.13 MJ/kg ME) afterwards. Water was freely available. Productive traits measured were hatch weight, individual body weight, weight gain, relative growth rate, feed intake and feed conversion for each pen.

Birds were individually placed into a heat challenge compartment and exposed to short term heat stress (35°C or 30^{o}C as control) between 3, 4, and 5 weeks of age to evaluate the reaction of birds to high temperatures. From each strain, 24 experimental birds were randomly chosen per week. Temperature during heat challenge varied between 30±0.2^{o}C and 35±0.2^{o}C.

Before subjecting the birds to heat challenge test, the rectal temperature was measured using a digital thermometer to the nearest 0.1°C. The bird was then individually placed into the test apparatus for 15 minutes at 30°C or 35°C. The sequence of temperature within the tests was at random for the individual bird. During the heat challenge test, the latency until panting (minute) was directly measured using a stopwatch. After 15 minutes, the bird was taken out of the cage and its rectal temperature was immediately measured. For birds that did not start panting within 15 minutes, latency until panting was set to 15 minutes. In addition, the proportion of birds panting was calculated (%).

Data were analyzed using the General Linear Model (GLM) procedure of SAS (SAS Institute Inc., 1990). Least Square Means (LSM) were calculated and differences among mean were differentiated by Duncan's multiple range test. Strain differences in frequencies of birds panting were analyzed by Chi square tests (Siegel, 1985).

RESULTS AND DISCUSSION

Growth Performance

The three strains differed significantly in body weight, daily weight gain and relative growth rate until 5 weeks of age. At week 5 the white strain weighed the heaviest followed by the Nn and the red strain. The weight gain and relative growth rate associates with the growing capacity and the level of feed intake and conversion. The white birds (medium slow) consumed most feed and tended to convert it much efficient than the red and the Nn birds. Although the red and the Nn birds are slow growing broilers, starting from week 3 to the end of the experiment, the Nn birds tended to consumed more feed than the red birds with the same level of conversion resulted in more weight gain and higher relative growth rate than the red birds. At high ambient temperature, feather coverage was negatively correlated with body weight gain because a higher body temperature results in a larger growth depression because of heat (Cahaner *et al*., 1993; Eberhart and Washburn, 1993). This result is in line with Bordas *et al*. (1978) and Yahav *et al*. (1998) that reported that the naked neck birds tend to gain more weigh at high ambient temperature and consume more feed. At the end of the rearing period, the red and the Nn birds weighed respectively about 64% and 72% from the body weight of the white strain (Table 1). The body weight development of each strain of birds from hatch until 5 weeks of age is illustrated in Figure 1.

Deep Body (Rectal) Temperatures

The strain, age and level of heat challenge influenced significantly on the rectal temperatures before (T0) and after (T1) heat challenge. The white birds have higher body weight than other counterparts and generate more heat and enhance deep body temperature which is reflected in higher rectal temperatures (T0 and T1) since metabolic production increases as the bird progresses in body weight (Lott *et al*., 1997). Although the Nn are heavier than the red birds, the reduction about 20% of feather coverage around the neck allows the Nn birds to dissipate higher rate of irradiation of the internally metabolic body heat to the environment through the unfeathered skin better than the feathered surface, thus improving thermoregulation under high ambient temperature as reflected by lower body temperature (Yahav *et al*., 1998) and reduces body temperature change when ambient temperature was elevated from 24 to 32°C (Deeb and Cahaner, 1999). Increased age decreased T0 and T1. Younger birds had higher T0 and T1 and decreased within the next age. All birds exhibit higher T0, T1 and TC when they were exposed to higher level of temperature (Table 2).

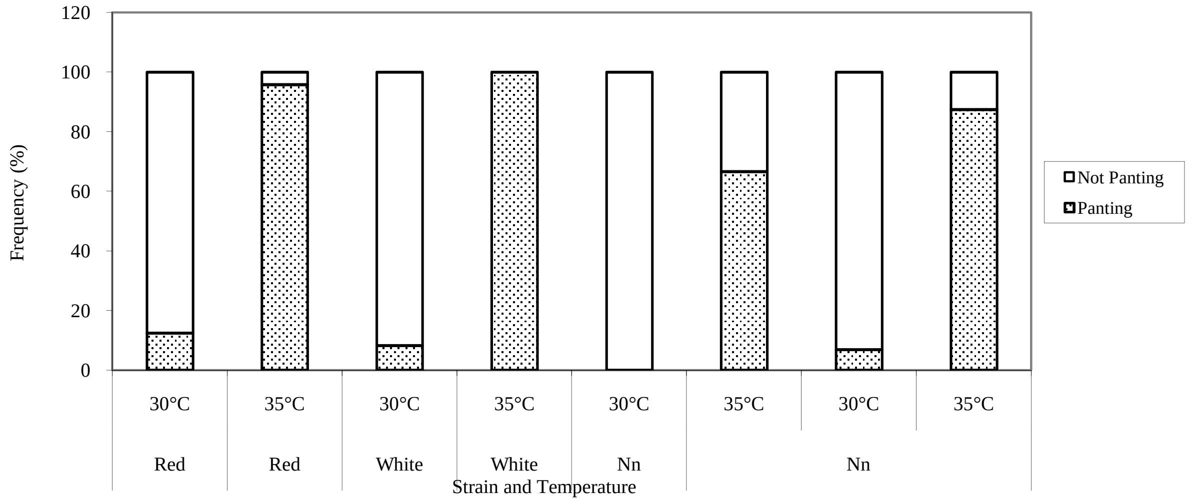

Figure 1. Distribution of frequency birds panting by strain and challenge temperature

Table 1. Productive performance of different strains of birds (LS-Means ± SD) by week

Traits	Age (d)	I657 (Red)	I957 (White)	S757 (Nn)	F	P
Body weight (g)	29-35	815.8 ± 81.2 ^{c}	1269.3 ± 136.3 ^{a}	924.0 ± 87.9 ^{b}	183.27	0.000
Weight gain (g/d)	29-35	33.9 ± 5.1 ^{c}	55.0 ± 7.3 ^{a}	42.3 ± 4.9 ^{b}	110.45	0.000
	Ø 1-35	22.0 ± 9.8	34.9 ± 17.6	25.5 ± 13.1		
Relative growth rate (%)	29-35	5.8 ± 0.6 ^{c}	6.2 ± 0.6 ^{b}	6.7 ± 0.5 ^{a}	21.79	0.000
	Ø 1-35	11.5 ± 5.5	13.9 ± 6.9	13.0 ± 6.1		
Average feed intake(g/d)	4-5	67.3	106.9	83.7		
	Ø 1-35	39.9 ± 21.5	62.0 ± 36.4	47.0 ± 27.3		
Feed conversion	4-5	1.98	1.94	1.96		
	Ø 1-35	1.74 ± 0.22	1.70 ± 0.21	1.77 ± 0.18		
% BW from white	29-35	64.3		72.8		

Note: $^{a, b, c}$ Means within the same row with different superscript differ significantly (P<0.05).

Table 2. Rectal temperatures (^{o}C) before, after and the difference of birds subjected to short-term heat stress in 3, 4 and 5 weeks (LS-Means ± SD)

Item		Rectal temperature (^{o}C)		
		T0	T1	TC
Strain	I567 (Red)	41.83 ± 0.64 ^{b}	42.43 ± 0.66 ^{b}	0.61 ± 0.31 ^{a}
	I957 (White)	41.95 ± 0.63 ^{a}	42.66 ± 0.66 ^{a}	0.71 ± 0.37 ^{a}
	S757N (Nn)	41.79 ± 0.66 ^{b}	42.40 ± 0.75 ^{b}	0.60 ± 0.31 ^{a}
		P=0.020	P=0.000	P=0.208
Age	3 weeks	42.67 ± 0.25 ^{a}	43.31 ± 0.34 ^{a}	0.64 ± 0.33 ^{a}
	4 weeks	41.51 ± 0.27 ^{b}	42.12 ± 0.45 ^{b}	0.61 ± 0.37 ^{a}
	5 weeks	41.39 ± 0.31 ^{c}	42.06 ± 0.37 ^{b}	0.67 ± 0.30 ^{a}
		P=0.000	P=0.000	P=0.639
Challenge temperature	30°C	41.79 ± 0.65 ^{b}	42.30 ± 0.69 ^{b}	0.51 ± 0.30 ^{b}
	35°C	41.92 ± 0.63 ^{a}	42.70 ± 0.64 ^{a}	0.77 ± 0.33 ^{a}
		P=0.003	P=0.000	P=0.000

Note: $^{a, b, c}$ Means within the same column with different superscript differ significantly (P<0.05);
T0= rectal temperature before heat challenge; T1= rectal temperature after 15 minutes of heat challenge; TC= temperature difference between T0 and T1.

Table 3. Latency until panting (min) of birds subjected to short term heat stress (LS-Means ± SD)

Item		Latency (min) ± SD	P
Strain	Red (I657)	12.86 ± 2.63 [b]	0.011
	White (I957)	12.44 ± 2.92 [b]	
	Nn (S757N)	13.63 ± 2.29 [a]	
Challenge temperature	30 °C	14.83 ± 0.76 [a]	0.000
	35 °C	11.12 ± 2.58 [b]	
30°C	Red (I657)	14.77 ± 0.83	0.067
	White (I957)	14.72 ± 1.03	
	Nn (S757N)	15.00 ± 0.00	
35°C	Red (I657)	10.95 ± 2.43	
	White (I957)	10.16 ± 2.36	
	Nn (S757N)	12.26 ± 2.61	

Note: [a, b, c] Means within the same column with different superscript differ significantly (P<0.05).

Latency Until Panting and Frequency of Panting

When ambient temperature raises and approaches body temperature the evaporative heat loss is significantly enhanced (Wiernuz and Teeter, 1996). The respiratory evaporation becomes the main avenue of heat dissipation (Hillman *et al*., 1985) and noticeable as panting in birds. Latency until panting of birds revealed significant strains and levels of heat challenge differences. The red and white birds started panting at the same time but earlier than the Nn birds. All strains began panting much earlier if they were challenged to higher level of heat stress (Table 3). The higher rate of the internally metabolic body heat and heat received from the environment can be more efficiently dissipated by means of sensible heat throughout the unfeathered skin around the neck in Nn birds. Decreasing of feather cover allows the Nn birds to dissipate more heat by means of sensible heat loss better than the other full feathered white and red strain. Therefore, the Nn birds started panting much later than the other counterparts, although over 3 weeks of age the Nn birds have more weight than the red birds.

The chi square analyses revealed a significant influence of the level of heat challenge on frequency of birds panting (P≤0.001). In red and white birds, about 12.5% and 8.3%; and 96% and 100% started panting if they were exposed to 30°C and35°C, respectively. None of the Nn birds started panting if they were exposed to 30°C, and about 67% to 35°C. The frequency of birds panting differed significantly if the birds were exposed to heat challenge at 35°C (P≤0.001). About 7% and 88% of birds exhibited panting if they were challenged to 30°C or 35°C, respectively (*Figure 1*).

CONCLUSIONS

Naked neck birds exposed higher adaptability and heat tolerance to high ambient temperature. Short-term heat challenge test was suitable to detect clear differences between genotypes.

REFERENCES

Berong, S.L. and Washburn, K.W. 1998. Effects of genetic variation on total plasma protein, body weight gains and body temperature responses to heat stress. Poultry Science. 77: 379-385.

Bordas, A., Merat. P., Sergent, D., and Ricard, F.H. MERAT. 1978. Influence du gene Na (cou-nu) sur la croissance, la consommation alimentaire et la composition corporelle du poulet selon la temperature ambiente. Annales de Genetique et de Selection animale. 10:209-231

Cahaner, A. and Leenstra, F. 1992. Effects of high temperature on growth and efficiency on male and female broilers from lines selected for high weight gain, favorable food conversion and high or low fat content. Poultry Science. 71: 1237-1250.

Cahaner, A., Deeb, N., and Gutman, M. 1993. Effects of the plumage-reducing naked neck (*Na*) gene on the performance of fast growing broilers at normal and high ambient temperatures. Poultry Science. 74: 968-975.

Deeb, N. And Cahaner, A. 1999. The effects of naked neck genotypes, ambient temperature, and feeding status and their interaction on body temperature and performance of broilers. Poultry Science. 78: 1341-1346.

Eberhart, D.E. and Washburn, K.W. 1993. Assessing the effect of the naked neck gene on chronic heat stress resistance in two genetics population. Poultry Sci. 72:1391-1399.

Hillman, P.E., Scott, R. and Van Tienhoven, A. 1985. Physiological responses and adaptation to hot and cold environments. Page 1-71 in Stress Physiology in Livestock. Vol III. Poultry. M.K. Yousef, de. CRC Press Inc., Boca Raton, FL.

Lott, B.D., Simmons, D. and May , J.D. 1998. Air velocity and high temperature effects on broiler performance. Poultry Science. 77: 391-393.

SAS Institute. 1990-2000. SAS® Users Guide: Statistics. Version 8e. SAS Institute Inc., Cary, N.C. 27513, USA.

Siegel, S. 1985. Nichtparamerische statistische Methoden. 2. Auflage. Fachbuchhandlung fuer Psykologie, Frankfurt am Main.

Sykes, A.H. and Fataftah, R.A. 1986. Effect of a change in environmental temperature on heat tolerance in laying fowl. British Poultry Science. 27: 307-316.

Wiernuz, C.J. and Teeter, R.G. 1996. Acclimation effects on feed and fasted broiler thermobalance during thermoneutral and high ambient temperature exposure. British Poultry Science. 37: 677-687.

Yahav, S., Luger, D., Cahaner, A., Dotan, M., Rusal, M. And Hurwitz, S. 1998. Thermoregulation in naked neck chickens subjected to different ambient temperatures. British Poultry Science. 39: 133-138.