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Effect of High Temperature *Per se* on Growth Performance of Broilers

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Abstract: Thirty two 4-wk-old broiler birds were grown in individual cages in two controlled-environmental chambers at 2 constant ambient temperatures (20 ±1°C Vs 35 ±1°C) until 8 wk of age. They were equally distributed into three treatments: 20°C, *ad libitum* feed consumption (20°C AL); 35°C, *ad libitum* feed consumption (35°C AL), and 20°C, pair-feeding on the daily feed intake of heat-exposed broiler birds. Water was provided for *ad libitum* consumption throughout the experimental period, which was lasted for 4 weeks. Body weight, feed intake, and feed conversion ratio were significantly reduced in broilers in heat stress group. At the same feed intake level (20°C PF Vs 35°C AL), heat-exposed birds gained less body weight and had significantly poorer feed conversion ratio (FCR). Moreover, rectal temperature and respiratory rate were significantly higher in heat stress group. These results indicated that high ambient temperature *per se* has a significant effect on growth rate depression rather than reduction in feed intake of heat exposed broilers.

Key words: Broiler, feed intake, growth, rectal temperature, temperature *per se*

Introduction

The detrimental effects of high ambient temperature on feed intake, growth rate, and feed efficiency of broilers are well documented (Hacina *et al*., 1996; Mashsly *et al.,* 2004; Ozbey and Ozcelik, 2004). It has been shown that feed intake of 4-8 wk old broilers is significantly (P<0.005) reduced when environmental temperature rise above the thermoneutral ambient temperature (18-21 C) (Yahav *et al*., 1996). The reduction in feed intake of heat-exposed broilers results in a decrease in daily intake of nutrients in order to reduce metabolic heat production and maintain homothermy. However, fewer nutrients are available to metabolize results in slower growth rate (Hacina *et al.*, 1996; Bonnet *et al,.* 1997). Dale and Fuller (1980) indicated that reduced feed intake is not the only factor responsible for slower growth rate of heat exposed birds, they found that growth rate depression of broilers reared at hot environment (24-35°C) was 25%, while it was 16% for the broilers maintained at cool environment (13-24°C) and fed the same amount of feed consumed by heat exposed birds. In addition, Hacina *et al.* (1996) studied the effect of two ambient temperatures, hot (32°C) and normal (22°C) on the performance of *ad libitum* (AL) fed and pair-fed (PF) broilers. Growth rate of heat exposed broilers (32C AL) and pair-fed birds (22C PF) was significantly (p<0.05) depressed by 30% and 20%, respectively. They concluded that, the direct effect of high ambient temperature is thus a decrease of growth rate and feed efficiency at the same feed intake level. However, most previous thermal environment studies were conducted under cyclic or short-term heat stress neither indicated nor explained the effects of temperature *per se.* Therefore, this study was designed to investigate the effects of chronic-constant high ambient temperature *per se* on growth performance of 4-8 wk old broilers.

Table 1: Ingredients and calculated composition of the basal diets

Ingredients and Composition	Starter (%)	Finisher (%)
Yellow corn	63.80	72.20
Soy bean meal (44% CP)	28.00	21.50
Fish meal (72% CP)	5.00	3.00
Lime stone	1.60	1.60
Dicalcium phosphate	1.00	1.20
Premix (Vitamin + Minerals)*	0.10	0.10
DL-Methionine	0.20	0.10
Sodium Chloride	0.30	0.30
Coccidiostat	0.05	0.05
Calculated Composition		
Metabolizable Energy (kcal/kg)	2921	2994
Crude Protein %	21.40	18.10
Lysine %	1.19	0.93
Methionine %	0.55	0.33
Methionine and Cystine%	0.89	0.62
Calcium %	1.09	1.08
Total Phosphorus %	0.98	0.68

*Vitamin and Trace element premix provides following per kilogram of the diet: Vitamin A, 37142857IU, VitaminD_3, 5714286IU, Vitamin E, 57143IU, Vitamin K, 857mg, VitaminB_1, 5714mg, Vitamin B_2, 17143mg, Nicotinic Acid, 100000 mg, Pantothinic Acid, 40000 mg, Vitamin B_6, 17143mg, Vitamin B_{12}, 71429 mcg, Folic Acid, 2857mg, Biotin, 1071mcg, Manganese, 242857mg, Iodine, 546mg, Zinc, 145455 mg, Iron, 109091mg, Copper, 14546 mg, Selenium, 182 mg, Antioxidant, 142857 mg.

Materials and Methods

Experimental room

Controlled-environmental chambers: Two controlled environmental chambers were used. The dimensions of the two chambers are 4.40 x 2.10 x 2.34 m and 4.60 x 2.40 x 2.34m. Each chamber was equipped with thermostatically controlled electric heaters and an electric fan for the circulation of air. Two holes of 20-cm diameter in both sides of the chamber were made to provide ventilation. A battery of 16 individual cages

Table 2: Means ± SE of live body weight (gram/bird), weight gain (gram/bird), feed intake (gram/bird), and feed conversion ratio (FCR) of pair-fed (PF) and *ad libitum* (AL) fed broiler birds reared at two different ambient temperatures

Performance parameter	Treatment			
	20°C / PF	35°C / PF	20°C / AL	35°C / AL
Body weight (g/bird)	1256.5^{b} ± 3	1038^{bc} ± 55	2274^{a} ± 12	926^{c} ± 54
weight gain (g/bird)	637.5^{b} ± 9	420^{b} ± 30	1605^{a} ± 33	390^{b} ± 30
Feed intake (g/bird)	1818^{b} ± 0	1818^{b} ± 49	3565^{a} ± 28	1851^{b} ± 79
FCR (g feed/g gain)	3.07^{c} ± .04	4.36^{a} ± .35	2.22^{b} ± .02	4.80^{a} ± .57

Means with different superscripts in the same raw are significantly ($p < 0.05$) different

arranged in two rows, were installed inside each chamber. Each cage measures 37 x 30 x 40 cm, and supplied with separate drinker and feeder. Ambient temperature can be controlled to the accuracy of ± 1°C.

Birds used in this study: One hundred day-old Cobb broiler chicks were obtained from a commercial hatchery and reared from one day to 4 weeks of age as a group using the standard brooding practices. They were reared on litter with feed and water provided *ad libitum*. They were fed a commercial standard starter diet from 0 to 4 weeks of age (Table 1).

At 28 days of age, 32 birds of growing broilers were moved from the brooding house and placed in the controlled environmental chambers. Birds were weighed and distributed randomly in the different individual cages. Sixteen birds were placed in each chamber. The environmental temperatures used were 20 ±1°CE and 35±1°C in the first and second chamber, respectively. Broiler birds kept at 20°C in the first chamber were divided randomly into 2 treatments. The first treatment was fed on *ad libitum* basis throughout the experimental period. The broilers of the second treatment were limited to the daily feed intake of the eight birds kept at 35°C. Broiler birds reared at 35 ℃ were weighed and fed on *ad libitum* intake at the previous day of the experiment. At the first day of the experiment, broiler treatments of 20°C chamber were weighed. Feed intake of the 35°C treatment was measured, the residual amount was deducted, and the average feed intake per bird was then calculated. Broilers of treatment two were offered the same average amount of feed intake, which was consumed by 35°C treatment at the previous day. This procedure was repeated every day throughout the experimental period. All birds received a complete finisher diet (Table 1) and water was provided for *ad libitum* consumption. The experimental treatments were birds kept at 20°C and fed on *ad libitum* intake, birds reared at 20°C and limited to the daily consumption of 35°C group, and birds reared at 35°C and fed on *ad libitum* intake throughout the experimental period which was lasted for 4 weeks. There were 2 replicates of 4 birds each, for each treatment. All the means of experimental treatments were analyzed by ANOVA using the General Linear Model (GLM) procedure of Statistical Analysis System (SAS). When a significant *F* statistic was noted treatment means were separated using Duncan's Multiple Range Test (SAS Institute, 1987).

Results

Data on performance of broiler finisher birds are presented in Table 2. Means of respiratory rate and rectal temperature of pair-fed (PF) and *ad libitum* (AL) broiler birds are shown in Table 3 and 4, respectively.

The results showed that, heat-exposed broiler birds fed *ad libitum* had significantly ($p < 0.05$) lower body weight gain than those of controls (20C AL). At the same feed intake level (20°C PF Vs 35°C AL), heat exposed birds gained less body weight and had significantly ($p < 0.05$) poorer feed conversion ratio (FCR). In addition, the rectal temperature and respiratory rate of the birds at 35°C did not significantly differ in the pair-fed and *ad libitum* fed birds. However, it was significantly ($p< 0.05$) higher than (20°C PF) birds from the second week till the end of experiment.

Discussion

Body weight, weight gain, and feed conversion ratio were negatively affected at high environmental temperature regardless of feeding regime (May and Lott, 1992). The reduction in body weight gain of pair-fed broilers reared at hot environmental temperature (35°C) was about 74 %, while the reduction in the pair-fed birds reared at 20°C was about 60% compared with the body weight gain of control (20°C AL) birds. This difference in growth depression data (14%) indicate that the depressed performance at 35°C may be not only due to feed consumption, but also, other factors responsible for growth rate depression mainly related to the effect of temperature *per se.* This is confirmed since there was no difference in the actual feed consumption between the pair fed and *ad libitum* fed birds (Table 2). These results were in agreement with the results of Hacina *et al.* (1996) who found that heat-exposed birds (32°C PF) had lower weight gain than (22°C PF) birds at seven weeks of age. The same findings were observed by Dale and Fuller (1980).

High temperature *per se* induces physiological changes in the birds such as a decrease in metabolic rate which in turn resulted in a decrease in feed consumption (Pyne, 1966), inefficient digestion and impaired

Table 3: Means ± SE of rectal temperature (Cº/bird) of pair-fed (PF) and *ad libitum* (AL) fed broiler birds reared at two different ambient temperatures

Week	Treatment			
	20°C / PF	35°C / PF	20°C / AL	35°C / AL
1	41.00[a]±0.1	41.95[a]±0.1	41.00[a]±0.1	41.40[a] ±0.4
2	40.80[b]±0	41.80[a]±0.2	41.10[b]±0.1	41.90[a] ±0.3
3	40.55[b]±0.1	42.10[a]±0.2	40.70[b]±0.1	42.50[a] ±0.1
4	40.50[b]±0	41.85[a]±0.1	40.50[b]±0.0	41.65[a] ± 0.1

Means with different superscripts in the same raw are significantly ($p < 0.05$) different

Table 4: Means±SE of respiratory rate (breathes/minute) of pair-fed (PF) and *ad libitum* (AL) fed broiler birds reared at two different ambient temperatures

Week	Treatment			
	20°C/PF	35°C/PF	20°C/AL	35°C/AL
1	34[c] ±1	138[a] ±1	39[b] ±1	138[a] ±1
2	29[c] ±1	139[a] ±4	34[b] ±1	135[a] ±2
3	29[c] ±1	136[a] ±2	32[c] ±1	130[b] ±7
4	30[c] ±1	133[a] ±3	36[b] ±1	129[a] ±2

Means with different superscripts in the same raw are significantly ($p < 0.05$) different

metabolism (Har *et al.,* 2000; Bonnet *et al*., 1997). Har *et al*. (2000) found that the passage rate of feed residue and the expelling of digesta from the crop or small intestine of heat-exposed broilers were decreased. They suggested that this inhibition might be caused by the excitement of sympathetic nerve or the decrease of trioiodothronine during the long-term effect of high ambient temperature. Moreover, the activities of trypsin, chymotrypsin, and amylase were reduced significantly ($p < 0.01$) of broilers exposed to 32°C. This reduction might be the reason for the reduction in amino acid digestibility in broilers exposed to high ambient temperature. Bonnet, (1997) found that digestibility of nutrients; protein, fat, and starch confirms this, it was significantly reduced in heat-exposed broilers by 4.2, 5.2, and 4.2 percentage units respectively.

The rectal temperature and respiratory rate of the birds at 35°C did not significantly ($p< 0.05$) differ in the pair-fed and *ad libitum* fed birds. This is an indication that the ambient temperature *per se* played an important role in the depressed performance observed. Panting was increased in heat stressed birds to dissipate heat, this mechanism requires expenditure of energy resulting in higher feed conversion ratios (Table 2) for heat-stressed birds. Furthermore, McDowell (1972) explained the reason for reduced feed efficiency at high ambient temperature by saying “ in warm climates, generally, chemical costs for a unit of production are higher than cooler climates because a portion is siphoned off for the process required to dissipate body heat”. Such a decrease in the efficiency of feed utilization coupled with depressed feed consumption and reduction in nutrient digestibility are, necessarily act to limit growth rate (Farrell and Swain, 1977; Bonnet *et al*., 1997; Har *et al.,* 2000).

Finally, it could be concluded that, not only reduction in feed intake, but also high temperature *per se* is responsible for growth rate depression of heat-stressed broiler birds*.*

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