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Productive Performance of Four Commercial Broiler Genotypes Reared under High Ambient Temperatures

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Abstract: An experiment was conducted to study the effect of High Ambient Temperature (HAT) on performance of four genotypes of broiler [Rose (RS); Cobb (CB); Hubbard (HB) and Lohmann (LN)]. A total of 700 day-old unsexed broiler chicks were used. Broiler chicks were obtained from four commercial parent stocks all bred in Iraq. Chicks (175 per genotype), 25 per pen, were housed in hall contained 28 pens (seven pens per genotype). Individual Body Weight (BW), in males and females, was determined at hatch and weekly then after at the end of experiment at 49 days of age. Feed Consumption (FC) and Conversion Ratio (FCR) and mortality percentage were determined per pen. All four genotypes were received starter diets (3005 Kcal/Kg feed; 22% CP) from one day to 28 days of age and grower diets (3059 Kcal/Kg feed; 20% CP) from 29 to 49 days of age. The genotype group differed significantly in BW and body weight gain (BWG), FC, FCR and mortality. The hot season effect was largest on BWG form 29-49 days of age along with reduction in FC and partially in FCR. The reduction in BW and BWG in both sexes (males and females) due to HAT appeared to be independent of sex. The greater reduction in FC and FCR was occurred in last period of study (42-49 days of age). This study suggested that standard broiler genotypes must be tested in our hot climates in summer season in order to find the one most suited to perform better in these conditions. Furthermore, it was prefer to marketing broilers at early ages (less than 42 days of age) to avoid the deteriorate effect of HAT on productive performance of broilers.

Key words: Broiler genotype, performance, high ambient temperature

INTRODUCTION

Environmental stress in Iraq due to High Ambient Temperature (HAT) is one of the biggest chronic problems that faced Iraqi broiler producers and breeders. The HAT has been a major factor hindering production of broilers in Iraq, especially, in July and August each year, where farmer cannot afford costly artificial control of normal ambient temperature in broiler houses. Reduced in poultry performance due to HAT in Iraq were described by Al-Hassani and Al-Jebouri, (1986, 1988); Mohammed *et al.* (2000); Razuki (2002); Razuki *et al.* (2007) and other countries (Leeson, 1987; Cahaner and Leenstra, 1992; Leenstra and Cahaner, 1992; Cahaner *et al.*, 1993; Eberhart and Washburn, 1993) are well established. The uses different tools such as modification of the diet by increased dietary energy, protein and critical amino acids (Mohammed *et al.*, 2000) or supplemented ascorbic acid (Razuki, 2002) or potassium and ammonium salts (Teeter and Smith, 1986) or by feed withdrawal technique (Abdul-Hassan and Al-Hassani, 2000) cannot elevated this problem due to growth rate and meat yield of contemporary commercial broilers is substantially depressed due to HAT (Howlider and Rose, 1987, 1989; Geraert *et al.*, 1996; Deeb and Cahaner, 2001, 2002). The negative effect of HAT have been more pronounced in chicken genotypes (breeds or lines) with higher BW and more rapid growth rate than in those with lower BW and growth rate (Adams and Rogler, 1986; Washburn *et al.*, 1992; Eberhart and Washburn, 1993; Yunis and Cahaner, 1999; Razuki *et al.*, 2007).

The continuous selection for increased in growth may increase broiler sensitivity to hot climates, therefore, the use of unsuitable genotypes in hot regions results in large economic losses due to decreased growth, reduced protein gain and higher mortality (Berrong and Washburn, 1998; Razuki, 2002). However, Razuki *et al.* (2007) found that the BW was lower for birds from three genotypes (Rose, Hubbard and Lohmann) reread under HAT compared with their counterparts reread under normal ambient temperature and also they showed the magnitude of this effect varied between genotypes.

The testing of different genotypes in hot climate may provide more useful information pertaining to specific genotype that can produced well in hot than in thermoneutral climates. In Iraq, the summer season characterized by HAT and all broilers used in the study and in field are imported from regions classified as cold or temperate. A study under HAT (summer season) was conducted to evaluate four commercial genotypes of broilers with respect to their performance.

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Table 1: Environmental temperature (°C) during the experimental period

Ages (days)	0800 h am	1000 h am	1200 h pm	1400 h pm	1800 h pm	2200 h pm	Min.	Max.	RH%
1-7	32	34	35	35	33	32	32	35	30.7
8-14	32	33	34	34	33	30	30	34	44.3
15-21	30	33	35	35	35	30	30	35	52.4
22-28	30	33	35	36	35	30	30	36	57.1
29-35	29	33	35	36	34	29	29	36	49.1
36-42	29	32	35	36	34	29	29	36	50.8
43-49	29	32	34	36	34	29	29	36	54.9

Table 2: Composition of experimental diets

Ingredients and composition	Starter diet 0-28 days of age	Grower diet 29-49 days of age
%		
Ground yellow corn	41.00	43.80
Wheat	13.30	16.10
Soybean meal (44% CP)	29.00	23.30
Protein concentrate[1]	10.00	10.00
Palm oil	4.00	4.00
Dicalcium phosphate	0.50	0.50
Limestone	1.80	2.00
Salt	0.30	0.30
DL-Methionine	0.10	-
Total	100.00	100.00
Nutrient composition[2]		
ME (kcal/kg)	3005.00	3059.37
Crude protein	21.98	20.05
Lysine	1.23	1.09
Methionine + cystine	0.91	0.77
Calcium	0.90	0.95
Available phosphorus	0.46	0.44

[1]Protein concentrated 2300 ME, Kcal/kg; 42% CP; 3% Lysine; 2.5% Methionine + cystine; 2.5% Phosphorus and other nutrient such as vitamins and minerals are met with NRC (1994) recommendations as labeled showed.

[2]Values of nutrients calculated according to NRC (1994) specifications

MATERIALS AND METHODS

Climates: Chicks hatched on 14/7/2005 were kept in closed house in poultry station/State Board for Agricultural Research. The summer season in Iraq provided the natural hot climate for this study. Temperatures and Relative Humidity (RH) in the center of the house were recorded continuously during the experimental period. The temperatures at 0800, 1000, 1200, 1400, 1800 and 2200 h and minimum and maximum of each day were averaged by week (Table 1).

Chickens: The chicks were obtained from four commercial parents stocks that found in Iraq in that time. The parents age of the genotypes of Rose (RS); Cobb (CB); Hubbard (HB) and Lohmann (LN) were 37, 40, 45 and 34 wk of age respectively, when eggs were collected and incubated in the same machine. All these genotype classified as fast-growing broilers.

Housing and management: A total of 700 day-old broiler chicks of Rose (RS); Cobb (CB); Hubbard (HB) and Lohmann (LN) were used in this study. All chicks were weighed and wing-band on the day of hatch. Each genotype (175 chicks) was represented by seven replicated floor pens were bedded with a wood-shavings litter and equipped with one feeder and one watered. Chicks were fed *ad libitum* from day to 28 days of age on starter diet (3005 Kcal/kg feed and 22% CP) and grower diet (3059 Kcal/kg feed and 20% CP) from 29-49 days of age (Table 2).

Measurements: Chicks were individually weighed at hatch, 7, 14, 21, 28, 35, 42 and 49 days of age and BW Gain (BWG) was calculated from 0-28, 29-49 and 0-49 days of age. Feed Consumption (FC) and Feed Conversion Ratio (FCR) were determined by pen (replicate) weekly and then summarized in periods from 0-28, 29-49 and 0-49 days of age. FC was adjusted for mortality. Mortality was recorded daily and summarized on a weekly basis.

Statistical analysis: Data of BW and BWG were subjected two-way analysis of variance with genotype and sex as the main effects. The following model was used:

$$Y_{ijk} = \mu + G_i + S_j + GS_{(ij)} + H_k + e_{ijk}$$

Where, Y_{ijk} the individual observation; μ = The overall mean; G_i = The genotype effect (i = 4); S_j = The sex effect (j = 2); $GS_{(ij)}$ = The genotype by sex interaction; H_k = The hatch weight that include as a covariate used to correct for the differences in age of dams between genotypes, which affect egg weight and hatch weight and consequently may affect BW and BWG and e_{ijk} = The random error associated with experimental unit.

The FC, FCR and Mortality were analyzed as one-way analysis of variance. The following model was used:

$$Y_{ij} = \mu + G_i + e_{ij}$$

Where, Y_{ijk} the individual observation; μ = The overall mean; G_i = The genotype effect (i = 4) and e_{ijk} = The random error associated with experimental unit. Duncan's multiple range test was used to compare the differences among treatment means. All statistical analysis by General Linear Models (GLM) procedure was carried out with SAS/STAT software (SAS Institute, 1992).

Table 3: Body Weight (BW) and BW gain (mean±SEM) of four broiler commercial genotypes reared under high ambient temperature and significant levels derived from two-way ANOVA

	Body weight and BW Gain (BWG) at day				
Variable	BW0	BW28	BWG0-28	BWG29-49	BW49
Genotype[1]					
RS	36.1±0.31[c]	1054±10.31[a]	1018±10.27[a]	1032±15.89[b]	2093±22.40[a]
CB	34.0±0.28[d]	957±11.60[b]	932±11.61[b]	1017±16.90[b]	1981±24.70[b]
HB	38.0±0.27[a]	1028±10.10[a]	990±10.06[a]	1113±16.30[a]	2140±22.60[a]
LN	36.3±0.31[b]	953±10.97[b]	916±10.96[b]	1051±15.89[b]	2006±23.73[b]
Sex[2]					
M	36.3±0.22[x]	1053±7.92[x]	1016±7.89[x]	1147±11.52[x]	2199±16.70[x]
F	35.9±0.21[y]	950±6.95[y]	914±6.94[y]	970±9.45[y]	1926±13.46[y]
Source of variation	Level of significant				
Genotype	0.0001	0.0001	0.0001	0.0001	0.0001
Sex	0.0001	0.0001	0.0001	0.0001	0.0001
Genotype x Sex	0.0001	0.4186	0.4092	0.1026	0.0903
BW0	-	0.0818	0.3243	0.0176	0.0182

[a-d]Genotype means within variable with no common superscripts differ significantly ($p<0.05$).
[x-y]Sex means within variable with no common superscripts differ significantly ($p<0.05$).
[1]Commercial broilers genotypes of RS = Rose; CB = Cobb; HB = Hubbard; LN = Lohmann. [2]Sex; M = Male; F = Female

Table 4: Body Weight (BW) (mean±SEM) of Males (M) and Females (F) from four broiler commercial genotypes reared under high ambient temperature and significant levels derived from one-way ANOVA

	BW at days								
	Males			Females			Deviation (%)[2]		
Variable	BW0	BW28	BW49	BW0	BW28	BW49	BW0	BW28	BW49
Genotype[1]									
RS	36.2±0.4[b]	1109±13.9[a]	2233±30.9[a]	36.1±0.40[b]	998±13.7[a]	1951±28.0[ab]	0.28	11.07	14.55
CB	34.3±0.4[b]	1005±15.0[c]	2073±33.9[b]	33.7±0.41[c]	925±13.7[b]	1893±27.4[b]	1.78	8.66	9.54
HB	38.2±0.3[a]	1067±15.3[ab]	2276±31.6[a]	37.8±0.41[a]	985±13.7[a]	1995±27.0[a]	1.06	8.39	14.06
LN	36.5±0.4[b]	1025±17.0[bc]	2203±32.2[a]	36.2±0.37[b]	905±12.3[b]	1878±24.3[b]	0.83	13.20	17.36
SOV	Level of significant								
Genotype	0.0001	0.0001	0.0001	0.0001	0.0001	0.0072			
BW0	-	0.0062	0.0001	-	0.1768	0.3538			

[a-c]Genotype means within variable with no common superscripts differ significantly ($p<0.05$).
[1]Commercial broilers genotypes of RS = Rose; CB = Cobb; HB = Hubbard; LN = Lohmann.
[2]100x (male-female)/(female). SOV = Source of Variation

RESULTS AND DISCUSSION

Significant differences in BW and BWG, due to genotype were found (Fig. 1; Table 3). The weekly BW of both sexes' together (Fig. 1) showed that the BW of HB and RS genotypes had higher than CB and LN genotypes. Mean BW and BWG of each genotype and sex are given in Table 3. The BW0 covariate significantly affected BW at 49 days of age and body weight gain from 0-28 days of age (BWG0-28) when the data analyzed for both sexes, but the BW0 effect was significant in later BW of males than females (Table 4). It appears, therefore, that BW0 corrected for most of variation, between genotypes, in age of dam effect on the performance of broilers. BW at 28 and 49 days of age of the HB and RS strains had significantly higher than that of CB and LN strains. BWG29-49 of RS strain was gained 1.36% higher than their counterparts at BWG0-28. However, the strains of CB, HB and LN was gained 8.36, 12.4 and 14.7%, respectively, higher than their counterparts at BWG0-28. That mean the little differences in BWG between two periods (0-28 days versus 29-49 days) may be due to birds in second period have had more internally heat that generated and cannot dissipated and consequently they may have difficult maintaining their body temperature at HAT, which lead to reduction BWG. The present finding are consistent with Yalcin *et al.* (1997), Razuki (2002) and Razuki *et al.* (2007) who showed the differences between genotypes in BW to be genotype dependent. The differences between genotypes in their growth at HAT are related to their genetic potential for growth rate (Cahaner and Leenstra, 1992). Razuki *et al.* (2007) showed that strains that perform better in normal ambient temperature cannot maintain their superiority for growth in HAT. That mean the negative effect of HAT have been more pronounced in chicken genotypes (breeds or lines) that have higher BW and more rapid growth rate than in those with lower BW and growth rate (Adams and Rogler, 1986; Washburn *et al.*, 1992; Eberhart and Washburn, 1993; Yunis and Cahaner, 1999).

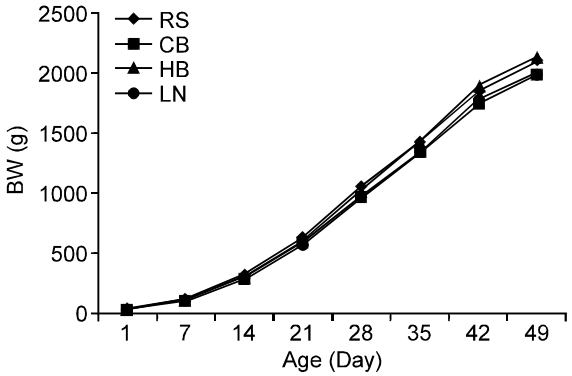

Fig. 1: Mean weekly BW of four broiler genotypes reared under high ambient temperature

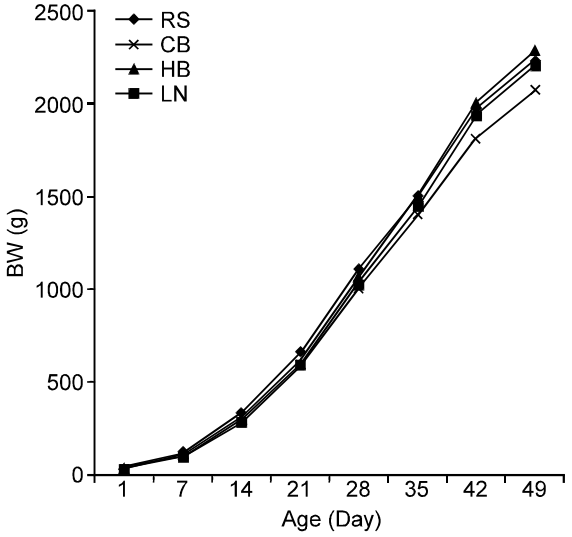

Fig. 2: Mean weekly BW of male of four broiler genotypes reared under high ambient temperature

BW and BWG of both sexes (Table 3) and BW of males was greater than females at all ages (Fig. 2 and 3; Table 4), that mean the effect of hot climate was to be independent of sex as shown by Kubena *et al.* (1972); Cerniglia *et al.* (1983); Howlider and Rose (1989) and Razuki *et al.* (2007). But some studies by researchers such as Gross and Siegel (1980), Osman *et al.* (1989) and Berrong and Washburn (1998) found the reduction in BWG due to HAT was larger and earlier in males than in females. BW of males was affected by genotype. Results (Fig. 3 and 4; Table 4) showed that the CB genotype exhibited lower BW of males and females than other strains it may be due to initial Body Weight (BW0) not for the strains itself. The differences between males and females in BW due genotype increased from 0.28% at day 0 of age in RS strain to 17.36% at day 49 of age in LN strain and the great differences were observed in LN strain and the lowest was found in CB strain.

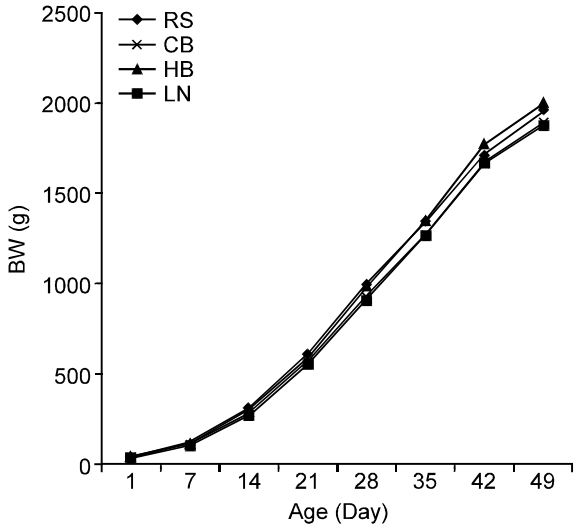

Fig. 3: Mean weekly BW of female of four broiler genotypes reared under high ambient temperature

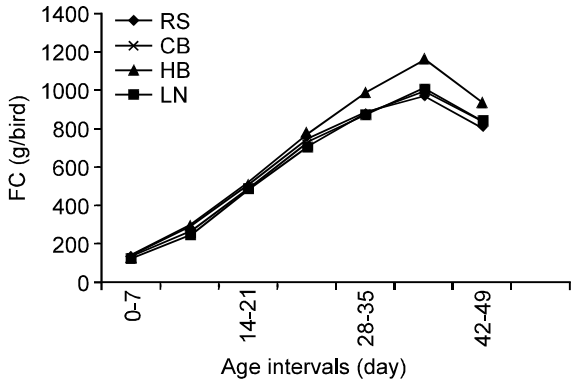

Fig. 4: FC (weekly averages, g/week) of four broiler genotypes reared under high ambient temperature

Feed consumption and Feed conversion ratio were affected significantly by genotype (Fig. 4 and 5; Table 5). The effects of HAT on the FC and FCR are shown in Fig. 4 and 5. There is a greater reduction in these two traits was occurred in last intervals (42-49 days of age) in all genotypes, which revealed that the magnitude of this depression increased with age, therefore, we advise to reared broilers in hot climates to 42 days of age or less due to these ages was suitable to reduce the negative HAT affects. From Table 5, the HB genotype consumed more feed and exhibited lower mortality percentage at all periods than other strains, whereas, the RS genotype exhibited better FCR and higher mortality percentage than other strains. The higher mortality percentage in this RS genotype may be due to higher energy intake which lead to increase fat deposition that caused increasing in body temperature. These results are

Table 5: Feed consumption, feed conversion ratio and mortality percentage (mean±SEM) of four broiler commercial genotypes reared under high ambient temperature and significant levels derived from one-way ANOVA

	Feed Consumption (FC) at ages			Feed Conversion Ratio (FCR) at ages			Mortality at ages		
Genotype[1]	0-28 days	29-49 days	0-49 days	0-28 days	29-49 days	0-49 days	0-28 days	29-49 days	0-49 days
RS	1664±11.81^{ab}	2656±50.92^{b}	4320±46.71^{b}	1.64±0.02^{b}	2.59±0.02^{b}	2.12±0.02^{c}	5.79±1.21^{a}	11.27±2.41^{a}	17.05±2.61^{a}
CB	1610±27.66^{bc}	2703±68.84^{b}	4314±84.70^{b}	1.73±0.03^{a}	2.70±0.07^{ab}	2.23±0.03^{ab}	4.07±1.58^{ab}	11.08±3.34^{a}	15.15±3.01^{ab}
HB	1719±14.08^{a}	3074±58.57^{a}	4793±58.59^{a}	1.74±0.02^{a}	2.77±0.05^{a}	2.28±0.03^{a}	0.57±0.57^{b}	7.67±1.93^{a}	8.29±2.25^{b}
LN	1564±28.56^{c}	2720±71.40^{b}	4284±90.06^{b}	1.71±0.03^{ab}	2.62±0.06^{ab}	2.19±0.03^{bc}	2.31±1.21^{ab}	6.61±2.06^{a}	8.92±2.73^{ab}
SOV	Level of significant								
Genotype	0.0003	0.0001	0.0003	0.0500	0.0500	0.0032	0.0304	0.4560	0.0500

$^{a-c}$Genotype means within variable with no common superscripts differ significantly ($p<0.05$).

[1]Commercial broilers genotypes of RS = Rose; CB = Cobb; HB = Hubbard; LN = Lohmann. SOV = Source of Variation

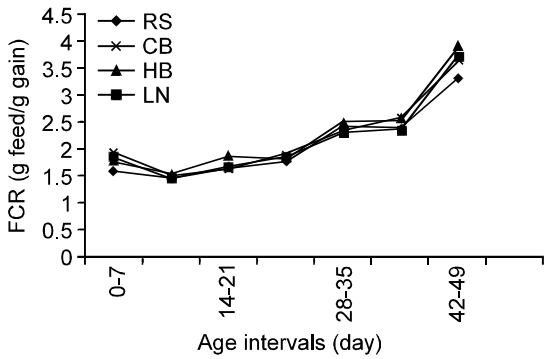

Fig. 5: FCR (weekly averages, g feed/g gain) of four broiler genotypes reared under high ambient temperature

consistent with Berrong and Washburn (1998), Razuki (2002) and Razuki and Al-Rawi (2007) who found that the FC, FCR and mortality are affected by genotype.

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