Comparison of growth performance of six commercial broiler hybrids in Iran

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Summary

An investigation was carried out to evaluate the growth performance of six commercial broiler hybrids available in Iran (Arbor Acres, Arian, Cobb 500, Hubbard, Lohmann and Ross 508). Two hundred and fifty fertile eggs of each hybrid were taken from different breeder farms, all over the country. The similarity of flocks ages and their health conditions were considered. After hatching, the sexed chicks were randomly assigned to six replicates of floor pens of 17 chicks, except the male Cobb hybrid which had five replications. All groups were managed in a similar way throughout the 56 days of study. Daily feed intake (FI) and daily body weight gain (BWG) were measured on weekly basis and the European production index (EPI) were calculated at 49 and 56 days of age. There were no significant differences among hybrids in FI during starter and grower periods ($P>0.05$), although significant differences were observed in finisher period ($P<0.01$). Differences in daily FI were significant between male and female chicks in grower and finisher periods ($P<0.05$), but not in starter period. Differences in daily BWG were significant among hybrids throughout the experiment ($P<0.01$). Sex significantly affected the daily BWG in all periods ($P<0.01$). The calculated EPI showed significant differences for both 49 and 56 days of age among hybrids and between two sexes ($P<0.01$). There were no significant differences among hybrids in carcass yield, percentage of breast and abdominal fat to carcass weight at 42 and 56 days of age. On day 42, males had more percentage of carcass and breast yield compared with females ($P<0.01$). Percent of abdominal fat in females on day 56 was more than that of the males ($P<0.01$), while on day 42 no significant differences were found in this respect.

Key words: Broiler, Performance, Hybrids

Introduction

The important economically traits in broilers are: growth rate, feed conversion ratio (FCR), mortality and carcass quality. The most important trait in broilers is growth rate. Genetics have been shown to have a major impact on the growth rate of broiler chicks (Smith and Pesti, 1998). The heritability of growth rate is about 4% and body weight gain (BWG) is negatively correlated with reproductive performance (Crawford, 1990).

Feed conversion (FC) of a flock is economically important to broiler producers. Many factors such as genetics, sex, lighting, temperature, ventilation, feed and water quality have influence on FC (Esmaeil, 2001).

The impact of rapid growth is on two aspects of physiology-skeletal development, heart and lung function. More generally it is important to consider whether selection for improved commercial traits must lead to an increase in mortality (Nir, 1998). Variation in carcass yield due to genetics was reported by Renden *et al*., (1992). Genetics have also been found to play a role in the abdominal fat pad weight of broilers (Jackson *et al*., 1982; Lecrercq, 1983; Barbato, 1992). Santos *et al*., (2004a) compared meat quality and carcass yield of the broiler chicken strains Cobb, Paraíso Pedrês (a Brazilian strain) and ISA Label. No significant interaction between strain and sex was observed for carcass yield and meat quality. However, it was found different among strains. Cobb broilers exhibited higher yielding of carcass (73.4), upper thigh (16.4) and breast (34.3) than Paraíso Pedrês (72.3, 15.7, 28.7, respectively) and ISA Label (71.7, 15.7, 28.5, respectively), while Cobb broilers presented lower abdominal fat content (1.96) than Paraíso Pedrês (3.20)

and ISA Label (2.76). There was no gender effect on meat quality. However, male broilers showed higher thigh and thigh+upper thigh yield than female, where-as female exhibited higher breast yield and abdominal fat content. Even though Cobb strain presented higher breast, thigh and thigh+upper thigh yield, Paraíso Pedrês and ISA Label exhibit distinct characteristics, which would better attend the consumers demand for a special meat.

The purpose of this investigation was to compare the growth rate, average body weight (BW), mortality percentage, European production index (EPI) and percentage of carcass yield, breast and abdominal fat among six commercial broiler hybrids in Iran (Arbor Acres, Cobb 500, Arian, Hubbard, Lohmann and Ross 508).

Materials and Methods

Chicks were obtained from eggs produced by 50 to 54 weeks old broiler breeder flocks from all over the country. After hatching, the sexed chicks were randomly assigned to six replicates of 17 chicks, except the male Cobb hybrid which had five replications. All groups were managed in a similar way throughout the 56 days of study. Each pen was equipped with 1 initial and 1 final feeder and automatic drinker.

Temperature was initially maintained at 33°C and gradually reduced by 2°C every week. Temperature was fixed at 24°C for the duration of experiment.

The lighting schedule was 23 hrs lighting per day. Relative humidity was about 60%. Birds were fed on a mash initially from day 1 to 21, on a grower diet from day 22 to 42 and on a finisher diet from day 43 to 56 (Table 1). Chickens were fed ad libitum during the whole period and they had free access to water. Feed formulation was performed to meet nutrient requirement of broilers recommended by the corrected NRC (1994) from day 1 to 56. Daily feed intake (FI), daily BWG, mortality percentage, carcass quality breast and abdominal fat percent were measured in starter, grower, finisher, 1-49-day-old and 1-56-day-old periods.

Average BW was calculated on days: 1, 21, 42, 49 and 56 of age. At the end of each week the chickens of experimental units were weighed on group basis and the daily BWG was calculated. At the end of the 7th and 8th weeks of age, 3 chicks were randomly chosen from each box and after 3 hrs of starving, they were killed according to animal welfare regulations. The carcass yield, percentage of breast yield and abdominal fat to carcass weight were measured in order to specify the effects of hybrid and sex, during different experimental periods.

All data were statistically analysed using GLM procedure of SAS. Comparison of means performed by Duncan's multiple range test.

Imbalanced completely randomized design in a factorial arrangement (6 hybrids × 2 sexes) was applied. Statistical model is as below: $X_{ijk} = \mu + B_i + S_j + BS_{ij} + \varepsilon_{ijk}$

Where, X_{ijk}: amount of each observation; μ: mean population; B_i: effect of hybrid; S_j: effect of sex; BS_{ij}: Interaction effect of sex by hybrid and ε_{ijk}: experimental error

Arc-sin transformation of percentage data were performed (Bartlett, 1947). Nutrient concentrations of rations were fixed according to the corrected NRC (1994) based on the common rations in Iran.

Results

Table 1 illustrates the ration ingredients. It shows that the energy and protein levels of rations are low. This can justify the lower performance in the experiment (Table 2 and 4).

Weight gain

The differences in daily WG were significant among hybrids throughout the experiment ($P<0.01$), (Table 3 and 4). The effect of sex and sex by hybrid interaction were significant as showed in Table 2 ($P<0.01$). Among the hybrids the greatest daily BWG was achieved by Cobb broilers, followed by Hubbard, Arian, Ross and Arbor Acres broilers in grower period ($P<0.01$). Lohmann broilers showed the lowest daily WG ($P<0.01$), (Table 4).

Body weight

The differences in average BW on days 42, 49 and 56 can not be attributed to differences in initial weight of the chicks except at 21 days of age. On the other hand, there was correlation only between initial weight and BW on day 21 (P<0.01). Hybrids and sexes showed different BW on day 56 (P<0.01). The highest final weight was achieved by Hubbard broilers, numerically higher than that of Cobb and Arbor Acres (P>0.01) which were similar to each other. Arian and Ross showed the same final BW numerically lower than that of Cobb and Arbor Acres, but Lohmann had the lowest BW among the hybrids (Table 6).

Table 1: Composition of the rations[1]

Composition	Ration		
	Starter	Grower	Finisher
	(%)		
Corn	59.5	61	60.8
Barley	0	2.3	10
Soybean meal	32	28.7	23
Fish meal	3	0.6	0.4
Salt	0.3	0.3	0.3
Dicalcium phosphate	0.9	0.9	0.7
Vitamin and mineral premix	0.5	1	0.5
DL- methionine	0.1	0.05	0.02
Animal fat	3.1	3.8	3
Oyster shell	1.1	1.3	1.3
Total	100.5	99.95	100.02
Calculated analysis			
ME (Kcal/Kg)	2900	2900	2900
CP (%)	20.85	18.13	16.32
Lysine (%)	0.99	0.90	0.77
Methionine (%)	0.46	0.35	0.29
Methionine + Cystine (%)	0.82	0.66	0.55
Calcium (%)	0.91	0.82	0.73
Available phosphorus (%)	0.41	0.32	0.28

[1]Starter = day 1 to 21, grower = day 22 to 42 and finisher = day 43 to 56 of rearing

Feed intake

There were no significant differences among hybrids in FI (P>0.05) during starter and grower periods, although significant differences were observed in finisher (42-56 days old) and whole period (P<0.01), (Table 5). The differences in daily FI were significant between the male and female chicks in all periods (P<0.01) except for starter (P>0.05), (Table 5).

Interaction effects of hybrid by sex except in finisher (P<0.01) were not significant (P>0.05), (Table 2). FI of Cobb, Hubbard and Arian hybrids were similar at 1-56-day-old period (P<0.01) and numerically higher than that of Lohmann and Arbor Acres broilers (P>0.01). Ross broilers showed the lowest FI (P>0.01), (Table 5).

Mortality

Strains disclosed different mortality percentages during the experiment (P<0.01), (Table 5). Mortality rate was not affected by sex and hybrid-sex interaction. Ross and Lohmann hybrids showed the lowest and the highest mortality, respectively (P<0.01), (Table 5).

Table 2: Results of statistical analysis of weight gain (WG), feed intake (FI) and Mortality percent (M)

Source of variation	Starter			Grower			Finisher			1-49 d.		
	WG	FI	M	WG	FI	M	WG	FI	M	WG	FI	M
Hybrid	**	NS	**	**	NS	**	**	**	*	**	**	**
Sex	**	NS	NS	**	**	NS	**	**	NS	**	**	NS

NS, *, **: not statistically significant, p<0.05, p<0.01, respectively

Table 3: Results of statistical analysis of BW, EPI and carcass yield

Source of variation	Average body weight					EPI		Carcass yield (%)		Breast yield (%)		Abdominal fat (%)	
Age (days)	IW	21	42	49	56	49	56	42	56	42	56	42	56
Hybrid	**	**	**	**	**	**	**	NS	NS	NS	NS	NS	NS
Sex	NS	**	**	**	**	*	**	**	NS	**	NS	NS	**
Hybrid × Sex	*	**	**	NS	**	NS	NS	NS	NS	NS	NS	NS	NS

NS, *, **: not statistically significant, p<0.05, p<0.01, respectively. IW: initial body weight

Table 4: Comparison of means and standard deviation of WG

Hybrid	WG (g/day)				
	Starter	Grower	Finisher	1-49 d.	1-56 d.
Hubbard	33.06 ± 2.94^{a}	58.96 ± 6.39^{a}	65.11 ± 6.98^{ab}	50.01 ± 4.49^{ab}	51.02 ± 4.75^{ab}
Arbor Acres	31.11 ± 1.99^{b}	57.14 ± 5.07^{ab}	62.45 ± 7.66^{b}	48.33 ± 3.44^{bc}	49.31± 3.72^{ab}
Cobb 500	30.78 ± 1.66^{b}	60.73 ± 4.77^{a}	68.36 ± 13.65^{a}	50.90 ± 4.77^{a}	51.42 ± 5.13^{a}
Arian	31.29 ± 2.30^{ab}	58.58 ±4.57^{a}	65.11 ± 2.44^{ab}	48.52 ± 2.16^{bc}	49.77 ± 2.22^{ab}
Ross 508	30.09 ± 1.46^{b}	57.74 ± 8.29^{ab}	64.99 ± 2.98^{ab}	47.57 ± 3.83^{c}	49.01 ± 3.9^{b}
Lohmann	27.97 ± 1.27^{c}	53.43 ± 4.77^{b}	67.08 ± 7.15^{a}	45.22 ± 3.04^{d}	46.81 ± 3.21^{c}
Sex					
Male	31.49 ± 3.43^{A}	61.81 ±4.97^{A}	70.90 ± 6.41^{A}	51.26 ± 3.21^{A}	52.72 ± 2.71^{A}
Female	29.95 ± 2.28^{B}	53.75 ± 3.98^{B}	60.19 ± 4.06^{B}	45.60 ± 2.98^{B}	46.43 ± 3.91^{B}

ab (AB): Values with different superscripts within a column differ significantly (P<0.01)

Table 5: Comparison of means and standard deviation of FI and mortality (M)

Hybrid	FI (g/day)					M (%)				
	Starter	Grower	Finisher	1-49 d.	1-56 d.	Starter	Grower	Finisher	1-49 d.	1-56 d.
Hubbard	42.92 ±3.11	121.12 ±11.78	195.88 ±17.87^{a}	84.35 ±7.05^{ab}	92.51 ±7.71^{a}	6.0 ±0.05^{b}	2.0 ±0.02^{b}	4.0 ±0.03^{a}	11 ±0.07^{bc}	12 ±0.08^{abc}
Arbor Acres	41.19 ±2.81	120.58 ±10.79	182.98 ±11.90^{b}	80.14 ±4.28^{bc}	89.16 ±5.05^{ab}	7.9 ±0.07^{b}	0.5 ±0.1^{b}	2.2 ±0.05^{ab}	10 ±0.07^{bc}	10 ±0.07^{bc}
Cobb 500	42.29 ±1.62	125.39 ±5.69	196.28 ±31.72^{a}	86.22 ±7.00^{e}	92.66 ±8.29^{a}	9.8 ±0.08^{ab}	5.0 ±0.03^{b}	1.0 ±0.02^{ab}	11 ±0.05^{abc}	11 ±0.07^{abc}
Arian	42.47 ±1.81	127.60 ±7.82	188.48 ±18.83^{ab}	81.11 ±7.08^{bc}	92.30 ±8.21^{a}	9.0 ±0.07^{b}	7.0 ±0.06^{b}	2.0 ±0.04^{ab}	16 ±0.06^{ab}	16 ±0.06^{ba}
Ross 508	40.65 ±2.22	119.55 ±13.48	183.28 ±17.08^{ab}	79.80 ±7.25^{bc}	87.24 ±6.97^{b}	3.5 ±0.04^{b}	5.0 ±0.01^{b}	1.0 ±0.01^{ab}	5.0 ±0.08^{c}	5.0 ±0.06^{c}
Lohmann	41.57 ±2.43	125.10 ±8.78	186.14 ±17.28^{ab}	78.32 ±5.02^{c}	89.51 ±6.02^{ab}	17.7 ±0.09^{a}	2.0 ±0.03^{b}	0.00^{b}	20 ±0.09^{a}	20 ±0.09^{a}
Sex										
Male	42.49 ±2.58	130.67 ±6.54^{A}	203.95 ±15.72^{A}	86.44 ±5.42^{A}	96.15 ±5.24^{A}	9.0 ±0.08	2.5 ±0.04	2.0 ±0.04	13 ±0.08	13 ±0.03
Female	41.20 ±2.76	115.96 ±7.54^{B}	173.94 ±9.57^{B}	76.84 ±3.97^{B}	85.06 ±6.24^{B}	8.0 ±0.07	1.8 ±0.03	1.0 ±0.05	11 ±0.09	12 ±0.04

ab (AB): Values with different superscripts within a column differ significantly (P<0.01)

Table 6: Comparison of means and standard deviation of BW and EPI

Hybrid	BW					EPI	
	Initial weight	21d.	42d.	49d.	56d.	49d.	56d.
Hubbard	47.79 ± 0.09^{b}	693.18 ± 71.99^{a}	1986.46 ± 216.5^{a}	2524.0 ± 224.7^{a}	2945.3 ± 317.8^{a}	222.37 ± 30.28^{a}	203.98 ± 28.93^{a}
Arbor Acres	49.5 ± 0.3^{a}	608.77 ± 32.89^{b}	1910.3 ± 122.9^{ab}	2360.9 ± 161.6^{b}	2811.3 ± 293.8^{ab}	175.23 ± 47.15^{c}	166.59 ± 32.51^{b}
Cobb 500	46.72 ± 0.06^{bc}	652.74 ± 33.09^{ab}	1920.2 ± 95.01^{ab}	2440.31 ± 215.7^{ab}	2847.6 ± 280.7^{ab}	218.53 ± 38.11^{ab}	197.42 ± 39.21^{a}
Arian	45.55 ± 0.08^{c}	661.30 ± 55.01^{ab}	1868.86 ± 122.9^{ab}	2359.7 ± 132.1^{b}	2707.3 ± 143.7^{b}	194.76 ± 31.17^{bc}	175.34 ± 36.7^{b}
Ross 508	45.77 ± 0.3^{c}	641.72 ± 26.68^{ab}	1812.07 ± 218.08^{b}	2326.4 ± 196.5^{bc}	2707.5 ± 263.2^{b}	220.30 ± 30.11^{ab}	203.89 ± 25.32^{a}
Lohmann	44.20 ± 0.2^{d}	621.10 ± 30.09^{b}	1644.67 ± 89.14^{c}	2143.3 ± 117.1^{c}	2498.9 ± 191.8^{c}	187.68 ± 36.28^{c}	171.25 ± 32.41^{b}
Sex							
Male	46.64 ± 0.2	664.54 ± 43.11^{A}	1937.82 ± 186.1^{A}	2465.2 ± 212.4^{A}	2935.8 ± 261.7^{A}	209.71 ± 48.27^{A}	197.44 ± 44.51^{A}
Female	46.55 ± 0.3	628.45 ± 52.02^{B}	1776.79 ± 142.02^{B}	2253.7 ± 143.2^{B}	2572.7 ± 167.5^{B}	196.33 ± 33.56^{B}	175.38 ± 38.23^{B}

ab (AB): Values with different superscripts within a column differ significantly (P<0.01)

Table 7: Comparison of means and standard deviation of carcass yield and abdominal fat ratio to carcass weight

Hybrid	Carcass yield (%)		Breast yield (%)		Abdominal fat (%)	
	42	56	42	56	42	56
Hubbard	61.35 ± 3.86	62.59 ± 1.60	34.26 ± 2.52	34.62 ± 3.51	2.19 ± 1.08	3.61 ± 3.19
Arbor Acres	60.48 ± 5.17	61.99 ± 5.05	32.67 ± 4.03	35.02 ± 2.57	2.167 ± 0.50	3.117 ± 0.70
Cobb 500	60.00 ± 6.35	61.70 ± 1.79	32.42 ± 3.91	34.50 ± 1.94	2.41 ± 1.00	3.77 ± 0.89
Arian	58.81 ± 3.14	61.36 ± 1.95	31.48 ± 2.04	35.51 ± 2.93	2.26 ± 1.25	3.19 ± 1.03
Ross 508	57.41 ± 6.74	61.24 ± 4.82	30.22 ± 4.16	32.57 ± 1.93	2.44 ± 0.51	3.95 ± 1.29
Lohmann	57.13 ± 2.17	59.18 ± 5.87	31.73 ± 2.59	33.74 ± 3.56	2.26 ± 1.11	3.18 ± 0.76
Sex						
Male	61.58 ± 4.59^{A}	61.93 ± 2.46	30.36 ± 2.64^{B}	34.68 ± 2.27	2.21 ± 0.80	3.12 ± 0.87^{B}
Female	56.89 ± 4.22^{B}	60.71 ± 5.09	30.88 ± 3.75^{A}	33.91 ± 3.42	2.36 ± 1.03	3.81 ± 1.06^{A}

ab (AB): Values with different superscripts within a column differ significantly (P<0.01)

European production index

Hybrids and sexes showed different EPI at 49 and 56 days of age (P<0.01), (Table 6). On day 56, Hubbard, Ross and Cobb broilers had the same EPI and higher than Arian, Lohmann and Arbor Acres which were similar (P<0.01). Males had higher EPI than females because of their high BW (P<0.01), (Table 6).

Carcass characteristics

There were no significant differences among hybrids in carcass yield, breast yield and abdominal fat percentages at 42 and 56 days of age (Table 7). On day 42, males had more percent of carcass yield compared with females (P<0.01), (Table 7). Percentage of abdominal fat in females on day 56 was more than that of the males (P<0.01), while on day 42 no significant difference was found.

Discussion

Weight gain

Since daily BWG is a quantitative trait and it is affected by genotype and environment, considering the stability of environmental conditions, the differences can be attributed to the type of the hybrid. The significant effect of hybrid on daily WG during the whole experimental period is the same as the results of the experiments done by Smith and Pesti (1998) and Gonzales *et al*., (1998a). The findings of this research show the priority of the males over the females from the economical point of view.

Santo *et al*., (2004b) compared the growth curve of two broiler strains, Paraíso Pedrês (a Brazilian strain) and ISA Label, raised in confined and semi-confined systems. They reported those males from both strains and systems exhibited higher growth rate than female birds. Males presented higher BWG (3841 g), FI (11.50 kg) and better FC (2.99) than females.

Body weight

Effect of hybrids on final weight in this study agreed with the results of Smith and Pesti (1998), Gonzales *et al*., (1998b), Pollock (1999) and Zuidhof (2002), other than Varmaghani *et al*., (2001). Correlation between BW and BWG is very high (0.9) (Crawford, 1990) and results of present study show this correlation clearly. During the experiment all hybrids revealed significant differences in BWG and BW (P<0.01).

Feed intake

Lesson (2002) has detected that the

energy level of rations has a considerable impact on FCR and FI. Lien *et al*., (2003) showed in relation to high energy, the cumulative consumption and FC were increased about 2% by low energy at 6 and 8 weeks of age. It seems that the birds eat so much that they can obtain their required energy (Lesson, 2002). It is believed that the birds eat to the highest level of their capacity.

The low amount of feed consumption regarding the chicks in the study in comparison with the feed consumption provided by the related catalogues could be because of the lack of activity of the birds due to restriction in pens and their closeness to drinker and feeder. Chicks with higher growth rate consume more feed, consequently FI of males is more than that of females.

Mortality

Renden *et al*., (1992) reported that continuous lighting program increased mortality in broilers (12-15 percent), whereas the acceptable standard of the related case is 4-5%; therefore, one of the effective factors of high mortality rate in this study could be continuous lighting program. In order to maintain the profitability of broiler production, the use of feed-restriction is away to improve viability without a significant loss of body weight at slaughter age (Gonzales, 1998a). In this study most mortality incidences were from SDS (Sudden death syndrome) and ascites syndrome. The hybrids of chicks significantly affected mortality in all periods (Table 2). However mortality percentage between sexes did not reveal any significant difference (Table 5). Metabolic disturbances such as SDS and ascites were the main causes of death, especially among those birds on the ad libitum feeding program (Gonzales, 1998b).

European production index

The decreased in EPI by age can explained by increase in length of production period, mortality and cull rate, so increase in live BW could not make it up. The higher EPI in males can be explained at least partly by relative higher BW in males.

Carcass characteristics

The results of this research are in agreement with the results of Oryani (1999) study about carcass yield and abdominal fat percentage. Results of Smith and Pesti (1998) showed no significant effect of hybrids on abdominal fat which is in accordance with present study.

Santos *et al*., (2004a) reported that no significant interaction between strain and sex was observed for carcass yield and meat quality. However, it was found different among strains. Cobb broilers exhibited higher yielding of carcass (73.4), upper thigh (16.4) and breast (34.3) than Paraíso Pedrês (72.3, 15.7, 28.7, respectively) and ISA Label (71.7, 15.7, 28.5, respectively), while Cobb broilers presented lower abdominal fat content (1.96) than Paraíso Pedrês (3.20) and ISA Label (2.76). However, male broilers showed higher thigh and thigh+upper thigh yield than female, whereas female exhibited higher breast yield and abdominal fat content.

Breast are usually more expensive than legs, therefore, it is important to get maximum carcass yield. Total carcass fat should be minimum, since it is greatly rejected by consumers.

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