IMPACT OF SHORT-TERM SELECTION FOR BODY WEIGHT AND GROWTH RATE ON HEMATOLOGICAL PARAMETERS, PLASMA CONSTITUENTS AND CARCASS TRAITS IN JAPANESE QUAIL.

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ABSTRACT:

Chicks of three lines of Japanese quail were used to study the effects of sex, line and age on hematology, growth and carcass traits in Japanese quail. The first line was selected for high 6 week-body weight (HBW_6) while second line was selected for high 0-6week growth rate (HGR_{0-6}) for three generations and the third line was randombred control (RC). Birds at 6 weeks of age had significantly higher values of live body weight (LBW), carcass%, dressing%, boneless meat% (BLM%), fat%, protein%, red blood cells (RBCs), total proteins (TP), globulin (Glob), triglycerides (TG), total lipids (TL) and growth hormone (GH) than those at 3 weeks of age. However, birds at 3 weeks of age had the highest hemoglobin (Hb), white blood cells (WBCs) and albumin (Alb) values as compared with those at 6 weeks of age. The HGR_{0-6} line had higher BW_6, performance index (PI), carcass%, dressing%, BLM%, TP, Alb, TL, triiodothyronine (T_3) and ratio of T_3 to thyroxine (T_3/T_4) than other lines. Females had significantly higher BW, PI, TP, Alb, Glob, TG and TL than males. Males had significantly higher carcass%, dressing%, BLM%, GH and T_3/T_4 than females. Significant line by age interactions were found for BW, carcass%, dressing%, fat%, protein%, Hb, PCV%, RBCs, TP, Alb, Glob, GH, T_3, T_4 and T_3/ T_4. It can be concluded that selection has a central role in variations in plasma constituents, hematological parameters and carcass traits which are related to differences in age and sex of Japanese quail.

Key words: Hematology, plasma, carcass traits, short-term selection, body weight, growth rate, Japanese quail.

INTRODUCTION

Variations in metabolic rate have a major influence on the growth and development of animals. Growth is controlled by a complex interaction between genotype and environmental factors which are largely translated in physiological signals by which these factors affect growth processes to improve productivity, productive efficiency and the quality of animal products **(Rahimi, 2005a)**. There is abundant evidence that thyroid hormones (T_3 and T_4) are very important for normal post hatch growth in birds which is positively correlated with the rising of circulating T_3 and T_4 **(Decuypere *et al.*, 1991)**. A higher metabolic rate is linked to an increased use of T_4 **(Decuypere *et al.*, 1982)**. Differences are also observed between fat and lean broilers divergently selected for abdominal fat weight **(Decuypere *et al.*, 1994)**. The growth hormone (GH) is considered to have a central role in growth; variations in circulating plasma growth hormone is related to differences in age, sex and strain of birds. GH has also been reported to affect lipid metabolism in birds **(Williams *et al.*, 1986)**. The RC lines exhibited

consistently higher GH levels than the larger, faster growing broiler lines **(Stewart and Washburn, 1983)**. No difference in T_3 plasma level between male and female chicks was found although growth rate differed as reported by **Khun *et al*. (1982)**. The relatively slower growth rate, increased carcass lipid **(Cravener *et al*., 1989)**. The hormones of the thyroid and GH axes are not only linked to growth and the incidence of ascites but also to protein and fat metabolism in broilers **(Buys *et al*., 1999)**. Relatively little is known, however, about the physiological mechanisms changes in the course of such genetic improvement. Also, little or no information is available on the relationship between hematological parameters and performance traits of Japanese quail. According to **Stewart and Washburn (1983)** genetic variations, manifested in the variability of tissue composition and metabolic processes between strains, provide a means of evaluating such physiological developmental changes due to genetic selection. Therefore, the present study aimed to investigate changes in hematological parameters, plasma constituents, performance index and body composition as influenced by age, line and sex following short-term selection for high 6 week-body weight and high 0-6 week growth rate in Japanese quail.

MATERIALS AND METHODS

Three quail lines were used in this study. Line HBW_6 was established by selection for high 6week-body weight, line HGR_{0-6} was established by selection for high 0-6week growth rate for three generations and RC line was the unselected base population from which the selected lines originated. Line RC was kept in order to facilitate comparison between lines and to provide a mean for correcting environmental trends or fluctuations brought about by artificial selection and to reduce random genetic drift in the control and selected populations used **(Havenstein *et al*., 1988)**. Details of management practices, chemical analyses and statistical treatments are mentioned elsewhere (**El Full *et al*., 2006)**.

Statistical analysis:

Using General Linear Models (**GLM**) procedure of SPSS software **(SPSS, 1999)**, analyses of variance of feed conversion (FC) and performance index (PI, **North, 1981**) were conducted as follows:

$$Y_{ijk}=\mu+ L_i +S_j+LS_{ij}+e_{ijk}$$

where: μ: Overall mean**, L_i:** Line effect (**i:** 1 and 3), S_j: Sex effect (**j:** 1 and 2), LS_{ij}: Interaction of line by sex and e_{ijk}: Random error term.

The following model was used for analysis of data for BW_6 **,** carcass traits (carcass%, dressing%, BLM%), body composition (fat%, protein%), hematological parameters (Hb, RBCs, WBCs and PCV%) and studied plasma constituents (GH, Alb, Glob, TG, TL, T_3, T_4, T_3/ T_4 and TP):

$$Y_{ijkl} = \mu+A_i + L_j +S_k+AL_{ij}+AS_{ik}+LS_{jk}+ALS_{ijk}+e_{ijkl}$$

where: μ: Overall mean**, A_i:** Age effect (i: 3 and 6)**,** **L_i:** Line effect (**i:** 1, 2 and 3), S_j: Sex effect (**j:** 1 and 2), **AL_{ij}:** Interaction of age and line**,** **AS_{ik}:** Interaction of age and sex, LS_{jk}: Interaction of line by sex, ALS_{ijk} : Interaction of line by age by sex and e_{ijkl}: Random error term. Means were compared for effects of line and interactions by Duncan's multiple range test (**Duncan, 1955**) when significant F values were obtained ($P \leq 0.05$).

RESULTS AND DISCUSSION

Means of productive traits (BW_6, FC, PI, carcass%, dressing%, BLM%, fat% and protein%), hematological parameters (Hb, PCV%, RBCs and WBCs), plasma metabolites (TP, Alb, Glob, TG and TL) and hormones (GH, T_3 and T_4) in different genetic groups of Japanese quail are presented in Table 1. Age significantly influenced ($P<0.01$) all studied productive traits, Hb, RBCs, WBCs, GH, TP, Alb, Glob, TG and TL. Chicks at six weeks of age had significantly higher estimates than three weeks for each of LBW, carcass%, dressing%, BLM%, fat%, protein%, RBCs, GH, TP, Glob, TG and TL being 183.57g, 68.50%, 73.35%, 49.56%, 9.69%, 21.39%, $3.65X10^6/mm^3$, 0.162ng/dl, 3.508g/dl, 2.612g/dl, 191.44g/dl and 1283.28mg/dl, respectively. However, birds at older age had significantly lower Hb, WBCs and Alb than at earlier age (10.49, 109.38 and 0.896 vs 12.38 g/dl, $152.78X10^3/mm^3$ and 1.495g/dl, respectively).

Line significantly affected all studied traits except protein%, WBCs, Glob, TG and T_4. The HGR_{0-6} line had higher BW, PI, carcass%, dressing%, BLM%, TP, Alb, TL, T_3 and T_3/T_4 (166.41g, 32.13, 68.33%, 73.68%, 47.80%, 3.444g/dl, 1.313 g/dl, 1034.08 mg/dl, 57.17 ng/dl and 362.78, respectively) than other lines. Whereas, the RC line had the lowest estimates for the previous traits compared to the selected lines and had significantly the lowest BW_6 and the poorest FC (143.23g and 5.70g feed/g gain). The HBW_6 line had significantly better FC, the highest GH but had insignificantly higher fat%, Hb, PCV% and RBCs than HGR_{0-6} line (Table 1). Although HGR_{0-6} had higher carcass%, dressing% and BLM% than other lines, birds of this line had significantly poorer FC than HBW_6 line. These results were confirmed by those reported by **El Full and Omar (2006).** Also**, Williams *et al*. (1986)** reported that there were variations in GH due to differences in age and strain of birds. The RC line had higher GH than HGR_{0-6} line. This result is in harmony with that reported for GH in broilers by **Stewart and Washburn (1983)**. Higher values of both T_4 and GH and lower T_3 estimates than the present study were reported by several investigators for broilers at 3 weeks of age (**Buyse *et al.*, 2001, Tona *et al*., 2004, Nijdam *et al*., 2005** and **Rahimi, 2005b**). Whereas, higher TG estimate for Pekin ducks was reported by **Farahat and Chavez (2000)**.

Sex significantly affected all studied productive traits except, fat%, protein% and all plasma constituents, except T_3 and T_4. Females had significantly higher BW_6, PI, TP, Alb, Glob, TG and TL than males as shown in Table 1. Although males had significantly higher carcass%, dressing% and BLM%, their PI were poorer than females, this may be due to the superiority of females growth than males at different ages. In addition, sex difference was attributed primarily to the relatively large ovaries, liver and intestines of the females especially at sexual maturity age (about 6 weeks of age). Consequently, when these parts were excluded, lower carcass% for females were obtained (**Wilson *et al.*, 1961, Farahat, 1998, Abdel Fattah, 2001** and **El Full and Omar,2006).** Males had significantly higher GH than females (0.164 vs 0.141 ng/dl). Similar trend was reported by **Williams *et al*. (1986)** that there was sex difference in GH in chickens. Conversely, sex insignificantly affected all studied hematological parameters (Table 1). Conversely, several investigators reported that males had significantly higher PCV% than females of Japanese quail (**Atwal *et al*., 1964, Mihailov *et al.*, 1999 and Abdel Azeem *et al.*, 2001**). Similar trends for PCV% and Hb were

Table 1

reported for the control line by **Abou Zeid *et al.* (2000)**. However, they found lower estimate for WBCs in Japanese quail than those found in this study. Similar trends of significant sex effect on T_3 , T4 and TG were reported by **Stewart and Washburn (1984), Buyse *et al.*(1991), Buys *et al.*(1999**) and **Rahimi (2005b**).

Significant line by age interactions in Japanese quail, regardless of sex are presented in Table 2. It can be seen that HGR_{0-6} line at 6 weeks of age had higher BW_6, carcass%, dressing%, fat% , protein%, T_3 and T_3/ T_4 than other groups. Similarly, HBW_6 line at 6 weeks of age had significantly higher PCV%, RBCs, GH and T_4 than other groups. Higher estimates of TP and Glob were shown for the RC line at 6 weeks of age than other groups. Lower protein% and GH values were obtained for HGR_{0-6} line at 3 weeks of age than other groups. Similarly, the RC line at three weeks of age showed significantly lower BW_6, carcass%, fat%, TP, Glob, T_3 and T_3/ T_4 than other groups as shown in Table 2.

Regardless of age, there were significant line by sex effects on carcass%, dressing%, BLM%, WBCs, TP, Alb, Glob, TL, GH, T_3 and T_4 presented in Table 3. Males of the HGR_{0-6} line had higher values for T_3 than other groups being 58.83ng/dl. Similarly, females of this line showed higher estimates for TP, Alb and TL than other groups. Males of HBW_6 line had higher carcass%, dressing%, BLM% and GH being 69.54%, 74.45%, 48.82% and 0.185ng/dl, respectively than other groups. Also, females of this line had higher WBCs and T_4 ($150.00x10^3/mm^3$ and 0.210ng/dl). Higher Glob of 2.631g/dl was shown for females of the RC line than other groups. However, males of HGR_{0-6} line had lower TL of 867mg/dl than other groups. Also, males of HBW_6 line had lower Alb of 0.984g/dl than other groups. Males of the RC line had the lowest TP and Glob values (2.645g/dl and 1.505g/dl, respectively). Similarly, females of this line had lower carcass%, dressing%, BLM%, WBCs, GH, T_3 and T_4 than other groups (65.46%, 70.86%, 43.99%, $108.33x10^3/ mm^3$, 0.137ng/dl, 26.00ng/dl and 0.137ng/dl, respectively) as shown in Table 3.

table 2

table 3

Table 4. Significant means ± SE for productive traits, hematological values and plasma constituents in Japanese quail (Age by sex interaction).

Trait	3weeks		6weeks	
	M	F	M	F
BW	127.08±0.17^{c}	130.94±1.4^{c}	176.07±2.3^{b}	191.08±2.3^{a}
Hb	12.009±0.26^{a}	12.757±0.14^{a}	10.963±0.45^{b}	10.030±0.41^{c}
RBCs	2.472±0.1^{d}	3.050±0. 03^{c}	3.800±0.14^{a}	3.500±0.13^{b}
TP	2.935±0.15^{c}	3.314±0.098^{b}	3.037±0.12^{bc}	3.979±0.098^{a}
Glob	1.567±0.12^{c}	1.693±0.095^{c}	2.282±0.16^{b}	2.942±0.12^{a}
TG	120.44±4.17^{b}	115.33±4.33^{b}	105.39±5^{b}	277.19±22.33^{a}
TL	663.11±18.5^{c}	641.11±17.17^{c}	1089.78±71.5^{b}	1476.78±87.33^{a}
GH	0.146±0.007^{b}	0.141±0.005^{b}	0.183±0.007^{a}	0.140±0.005^{b}

Means having different superscripts within the same row are significantly different at P≤0.0.

Regardless of line, age by sex interaction significantly affected BW_6, Hb, RBCs, TP, Glob, TG, TL and GH as presented in Table 4. Females at 6 weeks of age had the highest BW, TP, Glob, TG and TL compared to other groups. Also, males at 6 weeks of age had significantly higher RBCs and GH ($3.80x10^6$/ mm^3 and 0.183ng/dl) than other groups. The highest Hb value of 12.757g/dl was shown for females at 3 weeks of age. However, males at 3 weeks of age had lower estimates of BW, RBCs, TP and Glob (127.08g, $2.472x10^6$/ mm^3, 2.935g/dl and 1.567g/dl, respectively) than other groups as shown in Table 4.

The significant age by line by sex interactions on each of carcass%, dressing%, BLM%, RBCs, T_3, T_4 and T_3/T_4 are presented in Table 5. At 6 weeks of age, males of the HBW_6 had higher carcass%, dressing%, BLM% and RBCs (70.76 %, 75.30 %, 51.09 and 4.47 x 10^6 / mm^3) than other groups. However,

Table 5

females of the RC line at 6 weeks of age had the lowest carcass% and dressing% (64.75% and 69.57). Also, females of the RC line at 3 weeks of age had the lowest BLM% (41.25%). The lowest RBCs of $2.40x10^6$/ mm^3 was shown for males of the HBW_6 at 3 weeks of age. Males of the HGR_{0-6} line at 6 weeks of age had the highest T_3 and $T3/T_4$ (72.33ng/dl and 517.79).

On the other hand, females of the RC line at 3 weeks of age had lower T_3 and T_3/T_4 (10.0ng/dl and 70.89) than other groups. Each of females of HBW_6 line at 3 weeks of age, females of RC line at 6 weeks of age and both females of HGR_{0-6} line and males of HBW_6 at 6 weeks of age had the lowest estimates for T_4 of 0.130 ng/dl. However, females of the HBW_6 line at 6 weeks of age had higher T_4 estimate than other groups being 0.292ng/dl as shown in Table 5.

It can be concluded that selection has a central role in variations in plasma constituents, hematological parameters and carcass traits which related to differences in age and sex of Japanese quail birds.

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تأثير الانتخاب قصير المدى لوزن الجسم و معدل النمو فى السمان اليابانى على صفات الدم ومكونات البلازما وصفات الذبيحة

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استخدمت بيانات ٣ خطوط من السمان اليابانى لدراسة تأثير الجنس و الخط و العمر على صفات الدم و النمو والذبيحة فى السمان اليابانى. الخط الأول منتخب لصفة وزن الجسم العالى عند عمر ٦أسابيع بينما الثانى منتخب لمعدل النمو العالى من صفر – ٦ اسابيع لمدة ٣ أجيال و كان الخط الثالث هو خط المقارنة. كان للطيور عند عمر ٦ أسابيع قياسات أعلى لصفات وزن الجسم، نسبة الذبيحة، نسبة التصافى، نسبة التشافى، نسبة الدهن، نسبة البروتين، عدد كرات الدم الحمراء، البروتينات الكلية، الجلوبيولين، الجلسريدات الثلاثية، الدهون الكلية وهرمون النمو. بينما كانت للطيور عند عمر ٣ أسابيع قيما أعلى للهيموجلوبين، كرات الدم البيضاء والألبيومين. وكان للخط المنتخب لمعدل النمو العالى قيما أعلى لوزن الجسم، دليل الأداء الانتاجى، نسبة الذبيحة، نسبة التصافى، نسبة التشافى، البروتين الكلى، الألبيومين، الدهون الكلية، ثلاثى أيودوثيرونين (T_3) و نسبة T_3 الى الثيروكسين (T_3/T_4) مقارنة بالخطوط الأخرى. كانت للاناث قيما أعلى معنويا لكل من وزن الجسم، دليل الأداء الانتاجى، البروتينات الكلية بالبلازما، الألبيومين، الجلوبيولين، الجليسريدات الثلاثية، الدهون الكلية بالبلازما عن الذكور. والذكور كان لها نسبة ذبيحة، نسبة التصافى، نسبة تشافى وهرمون النمو ونسبة T_3/T_4 اعلى من الاناث. كانت هناك تداخلات معنوية راجعة الى الخط والعمر لصفات وزن الجسم، نسبة الذبيحة، نسبة التصافى، نسبة الدهن و نسبة البروتين، الهيموجلوبين، عدد كرات الدم الحمراء، البروتين الكلى فى البلازما، الألبيومين، الجلوبيولين وهرمون النمو، T_3 T_4 و T_3/T_4 . ويمكن الاستنتاج أن للانتخاب دورا رئيسيا فى الاختلافات التى ظهرت فى مكونات البلازما والمكونات الخلوية بالدم وصفات الذبيحة والمتعلقة كذلك باختلافات العمر والجنس لطيور السمان اليابانى.