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EGG QUALITY TRAITS AT DIFFERENT AGES AS AFFECTED BY SELECTION FOR HIGHER THREE WEEK BODY WEIGHT IN THREE GENERATIONS OF JAPANESE QUAIL

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ABSTRACT

The aim of the present study was to compare egg quality traits (egg weight, shell thickness, yolk index, Haugh unit score and the incidence of meat & blood spots) in a population of Japanese quail being selected for higher three week body weight by applying mass (MS) and pedigree based selection (PS) procedures along with running a random-bred control (RBC) group for three generations. A total of 180 eggs, comprising 60 eggs from each group (MS, PS and RBC) separately at three different ages (eight, fourteen and twenty weeks) were subjected to egg quality analysis in each generation. The data thus collected were subjected to Analysis of Variance (ANOVA) technique under Completely Randomized Design in factorial arrangement. Post-hoc analyses were conducted using Duncan's multiple range test. Statistical analysis of data revealed significantly improved egg weight in selected groups at all ages in each generation. Egg shell thickness also showed higher values for selected birds with advancing generations while yolk index and Haugh unit score showed significant variation without establishing any consistent trend. Hence, it can be concluded that selection for higher three week body weight did not cause any deterioration in egg quality characteristics, rather showed improvement in certain traits.

Key words: Selection, higher body weight, egg weight, shell thickness, yolk index, Haugh unit score.

INTRODUCTION

Eggs, either form chicken or quail are regarded as a complete diet with all essential nutrients and their quality is the major price contributing factor, hence, any deterioration in quality indices can cut down its overall economics by up to 5-8% (Krshavarz, 1994). Not only economics, egg quality traits also play vital role in breeding of poultry because hatching traits (Cavero and Schmutz, 2009), chick quality, growth and production performance in the subsequent generation are directly related with these traits (McDaniel *et al.*, 1978; Altinel *et al.*, 1996; Islam *et al.*, 2001). In continuation to the preceding discussion, the effect in the upcoming generations regarding egg quality might be caused by the genetic structure of the parents used in each generation (Sezer, 2007). Selection for higher body weight is found to have significant effect on egg quality parameters (Alkan *et al.*, 2010) and further strengthened by the fact that larger body size birds produce eggs with higher egg length, width and better internal egg qualities than those of smaller ones (Ricklefs, 1983). Selection for better hatchability is also in line with improved external egg quality as well as internal egg quality traits like the proportion of yolk. Whilst, relation between Haugh units and hatchability is inverse (Cavero and Schmutz, 2009). However, there still exists contradiction in literature regarding egg quality traits as affected by selection for higher or lower body weight. Hence, it was of utmost importance to have a well-planned and properly executed experiment to observe egg quality parameters as a consequent effect of selection for higher body weights. The present experiment is an effort in the same direction.

MATERIALS AND METHODS

The present study was conducted at Avian research and training (ART) Centre, UVAS, Lahore, with the aim of comparing egg quality traits in three generations of Japanese quail under three different selection systems for three week body weight.

Selection Process: In G1, 11000 quail chicks were randomly distributed into 22 sub-groups. After 3 weeks, birds were weighed and sexed; the higher body weight birds were selected as the parents of next generation. Out of these 22 sub-groups, first group was maintained with fully pedigree records, in second group birds were picked randomly without following any selection procedure, rest 20 groups were subjected to mass selection. The same procedure was repeated in the next two generations.

Egg Quality Parameters: A total of 180 eggs, comprising 60 eggs from each group (MS, PS and RBC) separately at 3 different ages (eight, fourteen and twenty weeks) were subjected to egg quality analysis in all the 3 generations. Data were collected for egg weight, shell thickness, Haugh unit score (Kondaiah *et al.*, 1983), yolk index (Funk, 1948) and the incidence of meat and blood spots.

Formulas for the estimation of Haugh unit score and yolk index (Alkan *et al.*, 2010) are given below:

Haugh Unit = 100 log $(H-1.7W^{0.37} + 7.6)$

Where "H" is the albumen height and "W" is egg weight in grams

$$\text{Yolk Index} = \frac{\text{Yolk Height}}{\text{Yolk Width}} \times 100$$

Egg weight was recorded with the help of digital weighing balance capable of measuring up to 0.1 g accuracy and shell thickness was measured using digital micrometer screw gauge.

Statistical Analysis: The data thus collected were analyzed according to Completely Randomized Design (CRD) under factorial arrangements using GLM (General Linear Model) procedures (Steel *et al.*, 1997). Differences among means were worked out using Duncan's (1955) Multiple Range (DMR) test with the help of SAS, 9.1. (2003), assuming following statistical model:

$Y_{ijk} = \mu + \alpha_i + \beta_j + (\alpha\beta)_{ij} + \varepsilon_{ijk}$

Where,

Y_{ijk} = Dependent variable

μ = Overall Population mean

α_i = First factor effect (i=3 generations)

β_j = Second factor effect (j=3 selection systems)

$(\alpha\beta)_{ij}$ = Overall interaction effect

ε_{ijk} = Residual effect

RESULTS AND DISCUSSION

Egg weight: Among different generations egg weight showed significant ($P \leq 0.05$) improvement with the advancement of generations i.e. higher values for generation three at the age of fourteen (12.71±0.1076g) and twenty (13.62±0.142g) weeks than those of generation one (12.17±0.0627g and 13.17±0.0838g) (Table 1). The comparison among different selection methods also showed significant variation ($P \leq 0.05$) in egg weight at all three ages with higher values for body weight in selected birds(PS and MS) than those of RBC. In the overall interactions (generations × selection methods) significant differences ($P \leq 0.05$) were observed with the highest value (11.46±0.188g) for PS in generation three and the lowest (10.38±0.378g) for RBC in the same generation at the age of eight weeks. Pedigree based selected birds also showed significantly higher egg weight at the age of 14 (13.03±0.130g) and 20 weeks (13.91±0.26g) in generation three. Improvements in egg weight in the current study in successive generations specially in pedigree based selected birds might be the result of improvement in body weight of the selected birds (Hussain *et al.*, 2013, 2014) as egg weight and body weight are positively correlated (Siegel, 1962; Festing and Nordskog, 1967; Jr Kinney, 1969). Improvement in egg weight in response to selection for higher body weight (Wilhelmson, 1980; Inal *et al.*, 1996; Alkan *et al.*, 2010) may be the consequent effect of increase in the size of ova along with increased albumen secretions (Altan *et al.*, 1998).

Shell thickness: Shell thickness among different generations showed significant variation ($P \leq 0.05$) at different ages with the higher values for generation three at the age of eight, fourteen and twenty weeks (table 1). Among different selection methods significantly lower values were observed for RBC than those of PS and MS. The results of the overall interaction (Generations × selection methods) also showed significantly higher values of egg shell thickness in higher body weight selected birds at the age of eight weeks than those of RBCs. Significantly ($P \leq 0.05$) higher egg shell thickness in selected (PS and MS) birds might be attributed to the additive genetic variance plus the superior body conditions of selected birds, leading to appropriate calcification in the shell gland. An improved shell thickness in high body weight selected lines is evidenced in another study (Alkan *et al.*, 2010) and it might be due to higher egg size and shell weight (Ricklefs, 1983). Shell thickness is reported to be an indicator of egg weight, hence, any improvement in egg weight consequently increases shell thickness (Selim and Seker, 2004).

Yolk index: Generation 2 showed significantly higher (48.12±0.687) yolk index ($P \leq 0.05$) at the age of fourteen weeks than those of Generation 1 and Generation 3 (table 2). Among different selection methods yolk index showed non-significant ($P > 0.05$) differences. In interactions between different generations and selection methods varying results were observed without establishing any trend. Yolk index is a function of height and width of yolk (Funk, 1948) and might have no relationship with yolk weight. The weak vitelline membrane may rupture due to any reason leading to deterioration in the quality of yolk (Kirunda *et al.*, 2001). Hence, the yolk index looks more to be a functional property of environmental factors than genetics as evidenced by another study (Hussain *et al.*, 2014) where the heritability estimates for yolk index were almost negligible. In some other studies non-significant variation in yolk index on the basis of strain variation (Rehman, 2006) and genetic groups (Haunshi *et al.*, 2006) has also been observed. Inconsistent trends for yolk index have been reported in some other studies too, where some of the authors have reported increased yolk index value as a result of selection (Alkan *et al.,* 2010) while, some others have reported decreased values both in selected and random bred control group as the generations progressed (Keener *et al*., 2006).

Haugh unit score: Haugh unit score differed significantly (P≤0.05) among different generations with the highest values for G2 at 14th week (99.66±0.860) and G1 at 20th week (100.94±0.734) (table 2). Among different selection methods mass selected birds showed significantly higher (P≤0.05) haugh units at 8th (94.22±0.7264) and 20th week (101.05±0.739) than those of PS and RBC. In the overall interaction between different generations and selection methods, mass selected birds depicted the highest haugh unit scores at different ages. Similar to these findings, some others studies (Keener *et al*., 2006; Sert *et al.,* 2010) suggested that increasing and decreasing trend in Haugh unit score might have been a product of change in environmental factors regardless of genotype (Hussain *et al.,* 2014). Some other scientists also could not find any significant difference in Haugh unit scores in light and heavy weight imported quails (Rehman, 2006) and chickens (Afifi *et al.,* 2010).

Incidence of meat and blood spots: Any reportable incidence of meat and blood spots was not observed in the eggs analyzed for internal egg quality traits at different ages (eight, fourteen and twenty weeks) in different generations and selection groups. This may be complemented to the nutritionists for carefully formulating (balanced) quail breeder ration, because a number of the scientists (Pingel and Jeroch, 1997) reported that the incidence of blood and meat spots can be seen due to low levels of vitamin A.

Table 1.Three generations comparative egg weight and egg shell thickness at the age of eight, fourteen and twenty weeks.

	Egg weight (g) Means ± SEM			Shell thickness (mm) Means ± SEM		
	8 week	**14 week**	**20 week**	**8 week**	**14 week**	**20 week**
Comparison between different generations						
G1	10.74±0.1073	12.17±0.0627^{b}	13.17±0.0838^{b}	0.17±0.0020^{ab}	0.17±0.0018^{b}	0.17±0.0016^{b}
G2	10.99±0.0886	12.58±0.0785^{a}	13.42±0.1041^{ab}	0.16±0.0015^{b}	0.18±0.0017^{a}	0.18±0.0016^{a}
G3	11.05±0.1517	12.71±0.1076^{a}	13.62±0.1429^{a}	0.17±0.0019^{a}	0.18±0.0026^{a}	0.18±0.0021^{a}
Comparison between different selection methods						
Mass	11.00±0.0332^{b}	12.56±0.0829^{a}	13.47±0.1053^{a}	0.17±0.0019^{a}	0.18±0.0024	0.18±0.0017
Pedigree	11.35±0.0839^{a}	12.68±0.0861^{a}	13.59±0.1137^{a}	0.17±0.0020^{a}	0.18±0.0019	0.18±0.0019
Random-bred	10.43±0.1671^{c}	12.21±0.0894^{b}	13.15±0.1196^{b}	0.16±0.0014^{b}	0.17±0.0021	0.18±0.0019
Overall interaction between different generations and selection groups						
G1 × Mass	10.74±0.0316^{bcd}	12.11±0.1086^{c}	13.11±0.1489^{b}	0.17±0.0040^{ab}	0.17±0.0037b^{c}	0.18±0.0031^{ab}
G1 × Pedigree	11.22±0.0306^{abc}	12.29±0.1140^{bc}	13.22±0.1493^{b}	0.17±0.0033^{ab}	0.17±0.0033^{c}	0.17±0.0032^{b}
G1 × Random-bred	10.27±0.2856^{d}	12.12±0.1039^{c}	13.19±0.1438^{b}	0.17±0.0029^{b}	0.16±0.0018^{c}	0.17±0.0023^{ab}
G2 × Mass	10.98±0.0242^{abc}	12.69±0.1179^{ab}	13.50±0.1734^{ab}	0.17±0.0034^{ab}	0.18±0.0028^{abc}	0.18±0.0027^{a}
G2 × Pedigree	11.35±0.1664^{a}	12.73±0.1560^{a}	13.64±0.1303^{ab}	0.16±0.0017^{b}	0.18±0.0028^{ab}	0.18±0.0032^{a}
G2 × Random-bred	10.65±0.1784^{cd}	12.32±0.1172^{bc}	13.11±0.2145^{b}	0.16±0.0027^{b}	0.17±0.0033^{bc}	0.18±0027^{ab}
G3 × Mass	11.30±0.0101^{ab}	12.90±0.1434^{a}	13.80±0.1961^{a}	0.17±0.0028^{ab}	0.19±0.0050^{a}	0.17±0.0032^{ab}
G3 × Pedigree	11.46±0.1882^{a}	13.03±0.1309^{a}	13.91±0.2615^{a}	0.18±0.0041^{a}	0.18±0.0035^{abc}	0.18±0.0031^{ab}
G3 × Random-bred	10.38±0.3780^{d}	12.19±0.2209^{c}	13.17±0.2578^{b}	0.16±0.0019^{b}	0.18±0.0046^{ab}	0.18±0.0046^{ab}

Different alphabets on means in a column show significant differences at P≤0.05

Conclusions: From the above discussion it can be concluded that egg weight increased with the advancement in generations in response to selection for higher three week body weight. Shell thickness also increased with advancing generations, however, yolk index and Haugh unit scores remained inconsistent among different generations and selection methods.

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Table 2. Three generations comparative Yolk index and Haugh Units values at the age of eight, fourteen and twenty weeks

	Yolk index Means ± SEM			Haugh unit score Means ± SEM		
	8 week	**14 week**	**20 week**	**8 week**	**14 week**	**20 week**
Comparison between different generations						
G1	44.78±0.9311	46.06±0.8710^{ab}	48.28±0.6421	94.05±0.6687	96.13±0.9112^{b}	100.94±0.7344^{a}
G2	42.57±0.7913	48.12±0.6871^{a}	48.50±0.5371	92.57±0.7043	99.66±0.8601^{a}	100.45±0.8859^{a}
G3	45.20±0.9553	44.12±0.9482^{b}	46.93±0.6913	92.35±0.9346	94.49±1.0249^{b}	97.43±1.0119^{b}
Comparison between different selection methods						
Mass	44.82±0.8819	45.49±0.8435	48.17±0.6827	94.22±0.7264^{a}	95.58±0.9938	101.05±0.7390^{a}
Pedigree	43.54±0.8720	47.11±0.8667	47.18±0.6054	91.34±0.8032^{b}	98.27±0.9570	97.88±1.0216^{b}
Random-bred	44.18±0.9599	45.70±0.8811	48.36±0.5976	93.40±0.7733^{ab}	96.43±0.9432	99.89±0.8908^{ab}
Overall interaction between different generations and selection groups						
G1 × Mass	44.69±1.6530^{abc}	46.54±1.4207^{a}	48.47±1.1115	93.27±0.9665^{ab}	96.24±1.6764^{ab}	100.75±1.3773^{ab}
G1 × Pedigree	46.84±1.1522^{ab}	47.36±1.9176^{a}	47.00±1.1495	95.32±1.0994^{a}	98.06±1.7973^{ab}	100.45±1.3545^{abc}
G1 × Random-bred	42.81±1.8939^{bc}	44.28±1.0501^{ab}	49.39±1.0635	93.54±1.3757^{ab}	94.09±1.1305^{bc}	101.61±1.1206^{a}
G2 × Mass	42.66±1.1984^{bc}	48.35±1.1510^{a}	48.95±0.9058	93.37±1.3418^{ab}	100.00±1.4001^{a}	102.88±0.6606^{a}
G2 × Pedigree	42.21±1.6191^{bc}	47.88±1.1113^{a}	48.15±0.9929	90.56±1.2503^{bc}	99.59±1.5565^{a}	96.39±2.0494^{bc}
G2 × Random-bred	43.38±1.3129^{abc}	48.13±1.3538^{a}	48.40±0.9293	93.78±0.9668^{ab}	99.40±1.5806^{a}	102.07±1.1655^{a}
G3 × Mass	47.66±1.5060^{a}	41.57±1.4111^{b}	47.09±1.4788	96.02±1.3882^{a}	90.52±1.4255^{c}	99.50±1.5646^{abc}
G3 × Pedigree	41.57±1.5041^{c}	46.10±1.4132^{a}	46.41±1.0123	88.14±1.3537^{c}	97.16±1.6493^{ab}	96.80±1.7782^{bc}
G3 × Random-bred	46.36±1.6995^{abc}	44.68±1.9557^{ab}	47.30±1.1036	92.88±1.6497^{ab}	95.80±1.9335^{ab}	95.99±1.8903^{c}

Different alphabets on means in a column show significant differences at P≤0.05

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