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Comparing Early and Late Feathering Genetic Groups of Baladi Chickens for Some Egg Quality Characteristics

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Abstract. A total of 320 twenty weeks-old slow and rapid feathering Saudi Arabian Baladi pullets, 160 of each genotype, were used to assess the effect of sex-linked feathering genotypes on egg and shell quality characteristics. Similar number of rapid feathering Leghorns pullets was included in the study for the purpose of comparison. The experimental birds of each genotypic group were randomly divided into four replicates and subjected to standard management practices. The trial lasted for nine 28 days periods. Ten eggs of each replicate were collected for three consecutive days during the last week of each production period to determine shell and egg quality characteristics.

Rapid feathering Baladi had statistically similar egg index, shell weight, shell density, Haugh unit value, blood and meat spots, yolk color grade and higher ($P< .05$) shell thickness, shell weight percent and shell weight per unit of surface area and lower ($P< .05$) egg weight and egg surface area than their slow feathering counterparts. Rapid feathering Leghorns had higher ($P< .05$) egg weight, shell weight, egg surface area and Haugh unit value and lower ($P<. 05$) egg index, shell thickness, shell weight percent, shell density, shell weight per unit of surface area and meat spots compared with rapid feathering Baladi but both genotypes had statistically similar blood spots and yolk color grades. However, slow feathering Baladi had statistically similar shell thickness and higher ($P< .05$) meat spots compared with rapid feathering Leghorns

Introduction

Few studies have been reported on the effect of sex-linked feathering genotypes (i.e. slow and rapid feathering genotypes) on some egg and shell quality characteristics. However, most of them revealed similar egg weight [1-3], normal and defective egg percentage [4] and specific gravity [5] for rapid and slow feathering genotypes. On the other hand, Havenstein *et al.* [5] indicated higher and O'Sullivan *et al.* [6] lower egg weight for rapid feathering compared with slow feathering genotype, whereas Katanbaf *et al.* [3] found more extra-calcified and compressed eggs for the same genotype. Statistically similar double yolk eggs [3,4] and blood spots [5] percentages were observed for the two genotypes. Information on the effect of sex-linked feathering genotypes on shell thickness, shell density, shell weight per unit of surface area, Haugh unit, yolk color grade and meat spots percentages are lacking. The study reported herein was, therefore, undertaken to assess the effect of sex-linked feathering genotypes on egg and shell quality characteristics of Saudi Arabian Baladi and to compare their values with those of rapid feathering genotypes of Leghorns.

Materials and Methods

Slow and rapid feathering Saudi Baladi were obtained from the Saudi Baladi population which has been randomly bred for several years in the Experimental Poultry and Livestock Farm of the Animal Production Department, College of Agriculture, King Saudi University. Hundred sixty 20 weeks-old pullets of each genotypic group were used in this study. The birds in each genotypic group were leg-banded and randomly allocated to four floor pens, 40 birds in each pen in an environmentally controlled house. Each floor pen was considered as a replicate. Five males of the same age and genotypic group were added to each replicate. Similar number (160) of early feathering Leghorns pullets which has been bred under similar conditions for many years were included in the study for the purpose of comparison. The birds received water and the commercial laying ration described in (Table 1) ad-libitum throughout the experimental period. Light was increased by half an hour weekly and maintained constantly at 15h light: 9 h dark. The trial lasted nine 28 days production periods.

Table 1. Commercial diets used in the experiment[1]

Nutrients	(%)
Crude protein (min.)	17.00
Crude fat (min.)	3.00
Crude fiber (max.)	5.50
Calcium (max.)	3.60
Phosphorus (min.)	0.60
Salt (max.)	0.35
M.E. Kcal/kg	2695

Ingredients:

Yellow corn, wheat millfeed soybean meal, meat and bone meal, Alfalfa meal, animal fat, molasses, oyster shell, calcium carbonate, phosphate, salt, methionine, manganese, iron, iodine, copper, cobalt, zinc, vitamins, A, D3, K, B12, riboflavin pantothenic acid, niacin, choline, chloride, ethoxyquin, fermentation producer.

[1]Manufactured by Grain Silos and Flour Mills Organization, Riyadh, Saudi Arabia.

Ten eggs of each replicate per day were collected for three consecutive days during the last week of each production period. The eggs were stored at 10-12°C for not more than two days. On the third day, the index of each egg (EI) was calculated as the ratio of width/length x 100. Eggs were individually weighed to the nearest .01 gram (EW), broken-out and the presence of blood and meat spots (BS and MS) was visually determined. Haugh unit values (HU) [7] were directly estimated using micrometer adjustable to egg weight and albumen height and directly gives Haugh unit values [8]. Yolk color grade (YC) was measured by Roch Color Fan, which has 15 color gradations from pale yellow to dark orange [9, pp. 735-737]. Shell thickness (ST) was measured at the middle part of the eggshell with membranes using "Ames Thickness Measure" to the nearest .001 inch and converted to millimeter prior to statistical analysis. Dried shell weight (SW) with membranes in gram was obtained and shell weight percent (SWP) was also calculated (dried shell weight/egg weight x 100). Egg surface area (SA) in cm^2 and shell weight per unit of egg surface (SWUSA) were obtained for each egg using the following equation suggested by Nordstorm and Ousterhout [10]:

$SA = 3.9782 \times \text{egg weight}^{0.7056}$

$SWUSA\ (mg/cm^2) = \text{shell weight (mg)/surface area } (cm^2)$

Shell density in gm/cm^3 (SD) was estimated for each egg according to the following equation suggested by Curtis et al. [11]:

$SD = \text{shell weight (gm)/surface area } (cm^2) \times \text{shell thickness (cm)}.$

Data collected were subjected to statistical analysis using SAS general linear model (GLM) procedure, according to the following model [12]:

$$Y_{ijk} = \mu + G_i + P_j + (GP)_{ij} + e_{ijk}$$

Where:

Y_{ijk} is the k^{th} observation of the i^{th} genotype (G), and j^{th} production period (P).

$(GP)_{ij}$ is the interaction between genotype (G) and production period (P).

μ is the general mean and e_{ijk} is the random error associated with y_{ijk} observation.

Results

Least square means and the effects of genotype (G), production period (P) are presented in Tables 2 and 3 and their interactions are shown in Figures 1-7.

Egg Weight (EW)

Rapid feathering Baladi (RB) had significantly ($P < .05$) lower EW than their slow feathering counterparts (SB), whereas rapid feathering Leghorns (RL) had significantly ($P < .05$) the highest EW (Table 2). The same Table also shows that EW significantly ($P < .05$) increased up to the last production period, with an exception during the 7th production period, which was statistically similar to that of the 6th production period.

Egg Index (EI)

No significant differences in EI were observed between early and slow feathering Baladi genotypes but rapid feathering Leghorns (RL) significantly ($P < .05$) recorded the lowest EI (Table 2). EI significantly ($P < .05$) reached its highest value during the first egg production period. However, the fluctuations in the EI values were small following the first production period. Fig. 1 shows that the different genotypic groups had statistically similar values during most of the production periods whereas rapid feathering Leghorns (RB) had significantly (P< .05) the lowest value at the first production period.

Table 2. Effect of genotype (G) and production period (P) on egg weight (EW), egg index (EI), shell weight (SW), shell thickness (ST), shell weight percent (SWP) and egg surface area (SA)

Independent variable	Egg parameters					
	EW (g)	EI^{1} (%)	SW (g)	ST (mm)	SWP^{1} (%)	SA (cm^{2})
Genetic group (G)	**	**	**	**	**	**
SB	45.69^{b}	74.30^{a}	4.49^{b}	0.351^{b}	9.87^{b}	58.95^{b}
RB	45.35^{c}	74.47^{a}	4.57^{b}	0.357^{a}	10.10^{a}	58.65^{c}
RL	52.31^{a}	73.82^{b}	4.88^{a}	0.350^{b}	9.36^{c}	64.87^{a}
SEM+	± .100	± .117	± .015	± .001	± .027	± .090
Production period(P)	**	**	**	**	**	**
1	44.23^{h}	75.14^{a}	4.60^{c}	0.346^{cd}	10.42^{a}	57.62^{h}
2	44.73^{g}	74.43^{b}	4.60^{c}	0.358^{a}	10.31^{a}	58.06^{g}
3	45.58^{f}	74.38^{bc}	4.61^{c}	0.352^{b}	10.16^{b}	58.84^{f}
4	46.77^{e}	74.14^{bcd}	4.50^{d}	0.345^{d}	9.66^{c}	59.92^{e}
5	48.41^{d}	73.75^{cd}	4.64^{bc}	0.351^{cd}	9.63^{c}	61.39^{d}
6	49.43^{c}	74.46^{b}	4.71^{ab}	0.358^{a}	9.55^{cd}	62.31^{c}
7	49.34^{c}	73.97^{bcd}	4.71^{ab}	0.360^{a}	9.57^{cd}	62.24^{c}
8	50.37^{b}	73.66^{d}	4.75^{a}	0.351^{b}	9.48^{d}	63.14^{b}
9	51.23^{a}	73.84^{bcd}	4.70^{ab}	0.352^{b}	9.21^{e}	63.88^{a}
SEM+	± .174	± .202	± .026	± .0017	± .048	± .156
Interaction (G*P)	NS	**	**	**	**	NS

SB : Slow Feathering Baladi. * : P<.05

RB : Rapid Feathering Baladi. ** : P<.01

RL : Rapid Feathering Leghorns. NS: Nonsignificant.

a-h : Means within column with different superscripts differ significantly (P<.05).

+ : Standard error of the mean.

[1]EI, SWP, were transformed to arc sin prior to statistical analysis.

Shell Weight (SW)

Slow (SB) and rapid (RB) feathering Baladi had statistically similar SW whereas rapid feathering Leghorns (RL) had significantly (P< .05) the highest SW (Table 2). SW values were significantly (P<. 05) the lowest at the fourth and the highest at the last four periods whereas they were statistically similar during the first three production periods (Table 2). Fig. 2 shows that rapid feathering Leghorns (RL) had significantly (P< .05) the highest SW whereas slow (SB) and rapid (RB) feathering Baladi genotypes showed statistically similar SW during all of the production periods.

Shell Thickness (ST)

Slow feathering Baladi (SB) and rapid feathering Leghorns (RL) had statistically similar ST, whereas rapid feathering Baladi (RB) had significantly (P< .01) the highest ST (Table 2). ST values were significantly (P< .05) the highest during the 2nd, 6th and 7th production periods and the lowest during the 1st, 4th and 5th production periods (Table 2). Fig. 3 shows that rapid feathering Baladi (RB) had statistically similar ST as their slow feathering peers and rapid feathering Leghorns at most of the

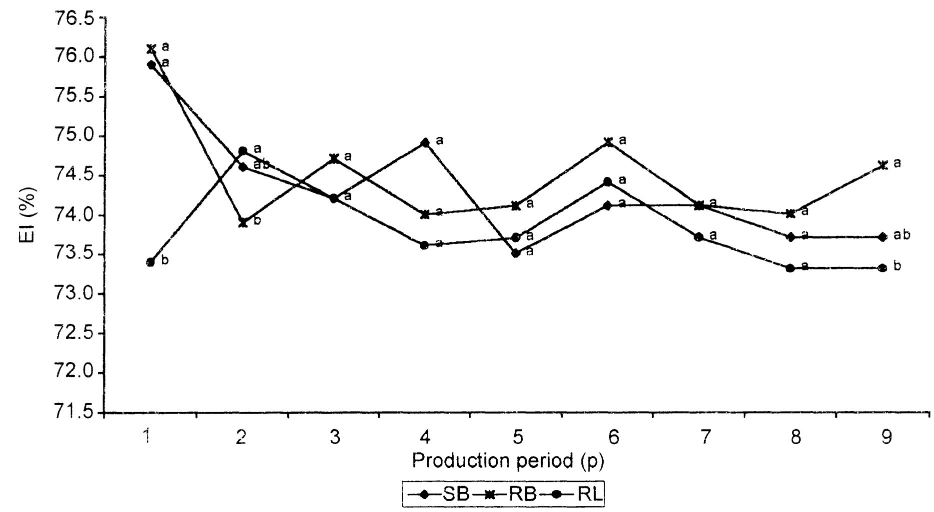

Fig. 1. Effect of G * on Egg Index (EI).

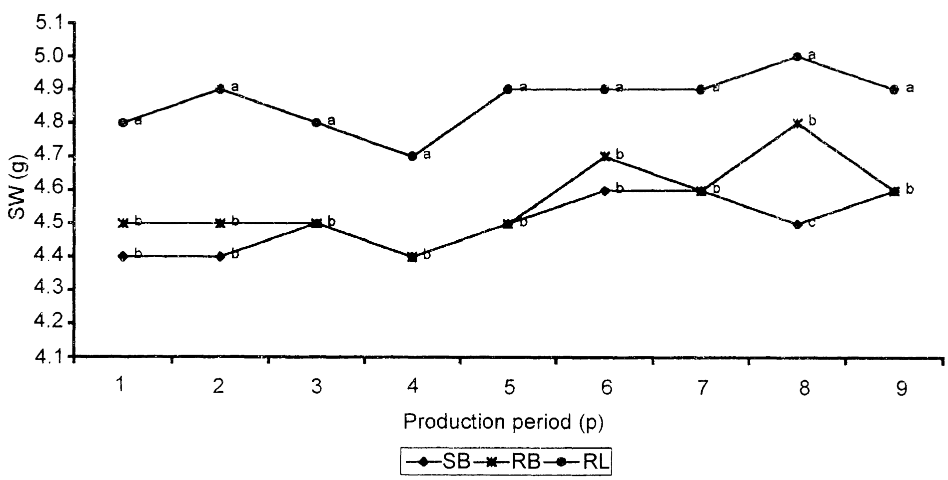

Fig. 2. Effect of G * P on shell Weight (SW).

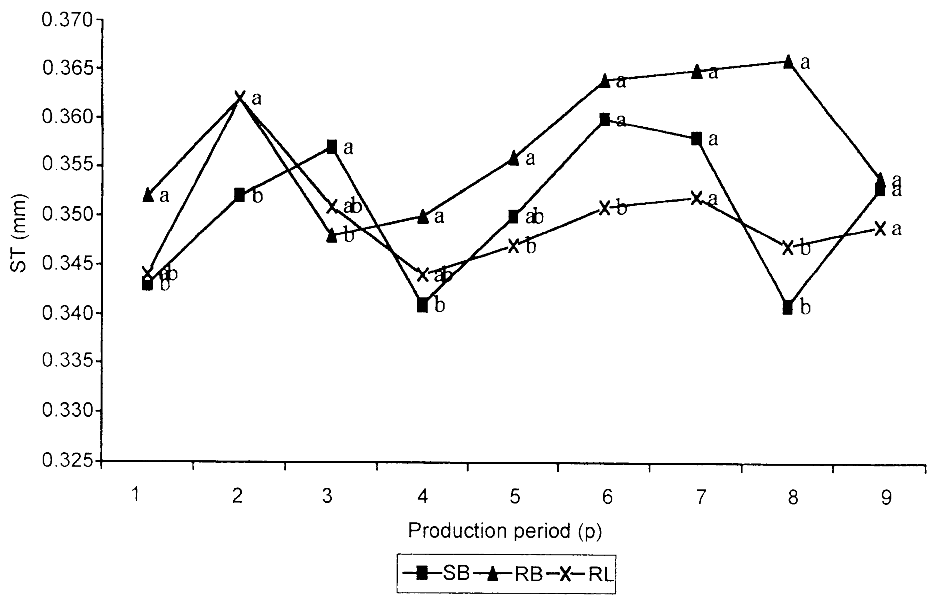

Fig. 3. Effect of G*P on Shell Thickness (ST).

production periods. However, rapid feathering Leghorns (RL) and Baladi (RB) had significantly (P< .05) the lowest and the highest value during the 6th and 8th production periods, respectively, whereas slow feathering Baladi (SB) recorded significantly (P< .05) the lowest value during the 2nd production period.

Shell Weight Percent (SWP)

Rapid feathering Baladi (RB) had significantly (P< .01) higher SWP than their slow feathering counterparts (SB) whereas rapid feathering Leghorns (RL) had significantly (P< .01) the lowest SWP (Table 2). The same Table also shows a sharp and significant (P< .05) decrease in SWP after the third production period, thereafter decreased gradually and significantly (P< .05) reached its lowest value at the last production period. As it is seen in Fig. 4, rapid feathering Baladi (RB) and Leghorn had significantly (P< .05) the highest and lowest values for most of the production periods, respectively.

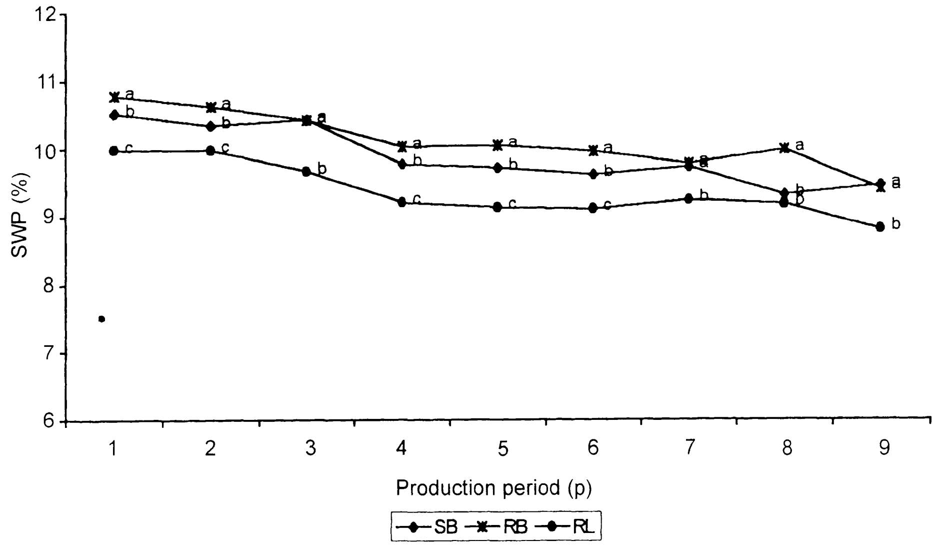

Fig. 4. Effect of G * P on Shell Weight Percent (SWP).

Egg Surface Area (SA)

Rapid feathering Baladi (RB) had significantly (P< .05) lower SA than their slow feathering peers (SB), whereas rapid feathering Leghorns (RL) had significantly (P< .01) the highest SA value. The same Table also illustrates that SA gradually increased and significantly (P< .05) reached its highest value during the 9th production period.

Shell Weight per Unit Surface Area (SWUSA)

Rapid feathering Baladi (RB) had significantly (P< .01) higher SWUSA than their slow feathering peers (SB), whereas rapid feathering Leghorns (RL) had significantly (P< .01) the lowest value SWUSA (Table 3). The same Table also indicates a sharp and significant (P< .05) decrease in SWUSA value after the third production period, and reached its lowest value (P< .05) at the 9th production period. Fig. 5 shows that the rapid feathering Baladi (RB) had significantly the highest value during the 1st, 5th, 6th and 8th production periods, whereas slow feathering Baladi (SB) and rapid feathering Leghorn (RL) had statistically similar values during most of the production periods. On the other hand, Leghorns had significantly (P< .05) the lowest value during the 3rd and 9th production period.

Table 3. Effect of genotype (G) and production period (P) on shell weight per unit of surface area (SWUight SA), shell density (SD), haugh unit values (HU), blood spots(SB), meat spots (MS) and yolk color grade (YC)

Independent variable	Egg parameters					
	SWUSA (mg/cm²)	SD (gm/cm³)	HU	BS[1] (%)	MS[1] (%)	YC
Genetic group(G)	**	**	**	**	**	NS
SB	76.30[b]	2.18[a]	74.15[b]	4.56[a]	10.14[a]	5.83
RB	77.95[a]	2.18[a]	73.60[b]	3.24[ab]	8.70[a]	5.81
RL	75.33[c]	2.16[b]	78.90[a]	2.22[b]	5.29[b]	5.76
SEM+	± .211	± .004	± .255	± .545	± .821	± .025
Production period(P)	**	**	**	N.S	**	**
1	79.88[a]	2.31[a]	78.87[a]	4.72	9.17[ab]	6.07[b]
2	79.23[a]	2.22[b]	77.15[b]	2.50	11.66[a]	6.29[a]
3	78.47[b]	2.23[b]	77.75[ab]	2.22	11.11[ab]	6.11[b]
4	75.20[c]	2.19[c]	74.76[cde]	3.33	7.78[ab]	6.26[a]
5	75.68[c]	2.16[d]	74.33[de]	3.06	8.33[ab]	6.13[b]
6	75.60[cd]	2.11[e]	75.86[c]	2.50	2.79[c]	5.32[d]
7	75.70[cd]	2.10[e]	75.35[cd]	1.67	3.33[c]	5.18[e]
8	75.36[d]	2.15[d]	73.79[e]	4.17	7.50[b]	4.90[f]
9	73.61[e]	2.09[e]	72.08[f]	5.99	10.77[ab]	5.95[c]
SEM+	± .370	± .008	± .442	± .945	± 1.438	± .043
Interaction (GxP)	**	**	NS	NS	NS	**

SB : Slow Feathering Baladi. * : P<.05
RB : Rapid Feathering Baladi. ** : P<.01
RL : Rapid Feathering Leghorns. NS: Nonsignificant.
a-f : Means within column with different superscripts differ significantly (P<.05).
+ : Standard error of the mean.

[1]BS and MS were transformed to arc sin prior to statistical analysis.

Shell Density (SD)

No significant differences in SD were observed between early (RB) and late (SB) feathering Baladi but rapid feathering Leghorns (RL) had significantly (P< .01) the lowest SD (Table 3). SD value was significantly (P< .05) the highest during the 1st production period, thereafter decreased significantly (P< .05) during most of the production periods reaching its lowest value during the 6th, 7th and 9th production periods (Table 3). Fig. 6 indicates that early feathering Leghorns had significantly (P< .05) the lowest SD value during the 3rd and 4th production periods whereas rapid and slow feathering Baladi had statistically similar values during most of the production periods.

Haugh Unit Value (HU)

No significant differences were found in HU between rapid (RB) and slow (SB) feathering Baladi whereas rapid feathering Leghorns (RL) had significantly (P < .05)

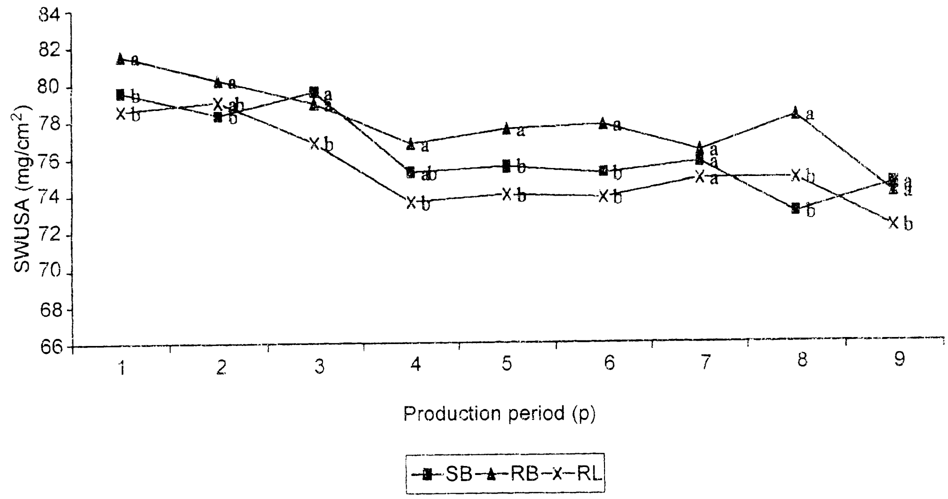

Fig. 5. Effect of G*P on Shell Weight per Unit of Surface Area (SWUSA).

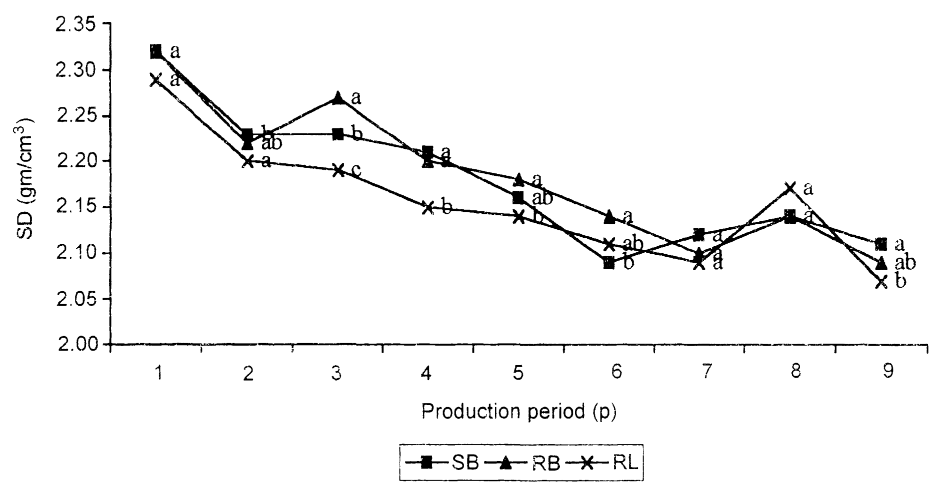

Fig. 6. Effect of G*P on Shell Density (SD).

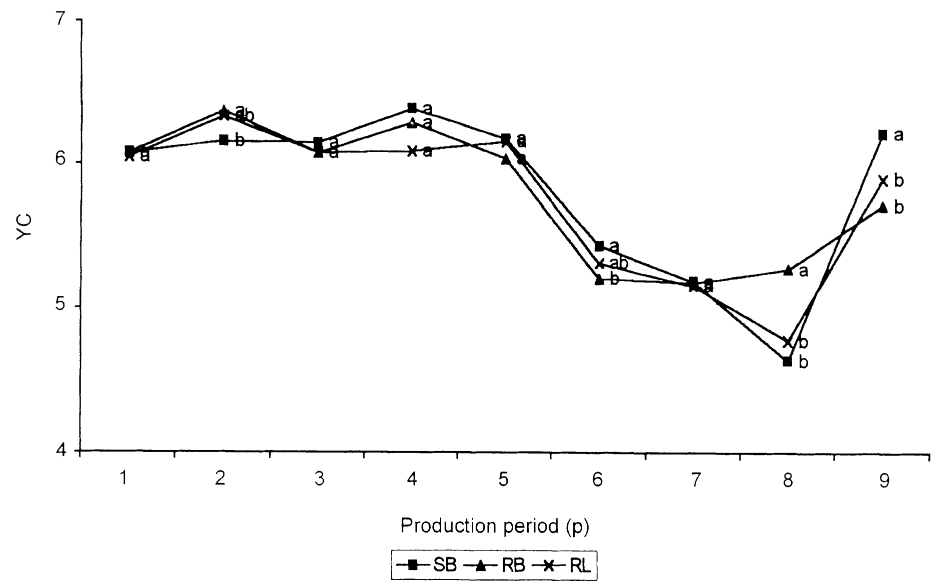

Fig. 7. Effect of G*P on Yolk Color Grades (YC).

the highest HU (Table 3). HU generally decreased after the 1st production period and then significantly (P< .05) reached its lowest value during the 9th production period (Table 3).

Blood and Meat Spots (BS and MS)

No significant differences were noticed between rapid (RB) and slow (SB) feathering Baladi for BS and MS, whereas the rapid feathering Leghorns (RL) recorded significantly (P< .01) the lowest MS value, but did not differ significantly from rapid feathering Baladi with regard to BS value (Table 3). The MS values were statistically similar during most of the production periods and they significantly (P< .05) reached their lowest values during the 6th and 7th production periods (Table 3).

Yolk Color Grade (YC)

Table 3 shows that the different genotypic groups had statistically similar YC. The same Table indicates that the values of the YC slightly fluctuated during the first five production periods and significantly (P<. 05) reached its highest value at the 2nd and 4th production periods, and recorded the lowest value at the 8th production period. Fig. 7 shows that the three genotypes had statistically similar values during most of the production periods, whereas rapid feathering (RB) and slow feathering Baladi (SB) had significantly ($P< .05$) the highest values during the 8th and 9th production periods, respectively.

Discussion

The two genetic groups of slow and rapid feathering Baladi had statistically similar egg index, shell weight, shell density, Haugh unit value, blood and meat spots and yolk color grade. On the other hand, slow feathering Baladi had significantly ($P< .05$) lower shell thickness and shell weight percent and higher egg weight and egg surface area than rapid feathering Baladi. The superiority of slow feathering Baladi in egg weight and egg surface area might be due to its lower hen housed egg production (49.56) compared to its rapid feathering peers (56.52) [13]. Similar results were reported by O'Sullivan et al. [6] with regard to egg weight. However, Saeki and Katsuragi [1]; Lowe and Garwood [2] and Katanbaf et al.[3] found statistically similar egg weight for rapid and slow feathering birds whereas Havenstein et al.[5] found higher egg weight for rapid feathering birds. Similar specific gravity, blood spots [5] and normal eggs [4] were also reported for the two genotypes.

Rapid feathering Leghorn recorded significantly ($P< .05$) higher egg weight, shell weight, egg surface area and Haugh unit and lower egg index, shell weight percent, shell density, shell weight per unit of surface area and meat spots compared with rapid and slow feathering Baladi. However, rapid feathering Baladi showed statistically similar blood spots and yolk color grade as rapid feathering Leghorns. On the other hand, slow feathering Baladi tended to have higher shell thickness and significantly ($P< .05$) higher meat spots compared with rapid feathering Leghorns. However the lower SWP, SWUSA and SD values might be due to the relatively low shell thickness compared to the other groups.

From the results of this study it seems that genetic groups classified according to sex-linked feathering genes significantly differed in most studied exterior egg quality traits.

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مقارنة مجموعات وراثية سريعة وبطيئة التريش من الدجاج البلدي لبعض صفات جودة البيض

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(قدم للنشر في ٦/٧/ ١٤١٩؛ وقبل للنشر في ٢٨/ ١٢ / ١٤٢٠ هـ)

ملخص البحث. استخدم في هذه الدراسة عدد ٣٢٠ من بدارى الدجاج البلدي بطيئة(S B) وسريعة التريش (RB)، ١٦٠ من كل تركيب وراثي، وذلك لدراسة تأثير المجموعتين الوراثيتين على بعض صفات جودة البيض والقشرة في الدجاج البلدي ، بالإضافة إلى ذلك استخدم عدد ١٦٠ من دجاج الليجهورن سريعة التريش (RL) بغرض المقارنة ، قسمت الطيور في كل مجموعة وراثية عشوائيا إلى أربع مكررات ، وربيت الطيور حسب الشروط المألوفة، واستمرت التجربة لمدة تسع فترات إنتاجية مدة كل فترة ٢٨ يوم، وتم جمع ١٠ بيضات من كل مكررة لمدة ثلاث أيام متتالية في الأسبوع الأخير من كل دورة إنتاجية لقياس صفات جودة البيض والقشرة في الدجاج البلدي.

تشير نتائج الدراسة إلى عدم وجود فروق معنوية بين الدجاج البلدي بطئ وسريع التريش فيما يخص دليل البيضة (EI)، وزن القشرة (SW)، كثافة القشرة (SD)، وحدات هاو (HU)، بقع اللحم (MS)، والدم (BS) ودرجة لون الصفار (YC) لكن الدجاج البلدي سريع التريش كان أعلى معنويا ($P < .05$) من نظيرة بطئ التريش فيما يتعلق في سمك القشرة (ST)، نسبة وزن القشرة (SWP) ووزن القشرة بالنسبة لمساحة سطح البيضة (SWUSA) وأقل منة معنويا ($P < .05$) في وزن البيضة (EW) ومساحة سطح البيضة (SA).

كذلك وضحت النتائج أن الليجهورن كان أعلى معنويا ($P < .05$) في وزن البيضة (EW)، وزن القشرة (SW)، مساحة سطح البيضة (SA)، وحدات هاو (HU) وأقل معنويا ($P < .05$) فيما يخص دليل البيضة (EI)، سمك القشرة (ST)، نسبة وزن القشرة (SWP)، كثافة القشرة (SD)، وزن القشرة بالنسبة لمساحة سطح البيضة (SWUSA) وبقع اللحم (BS) بالمقارنة مع الدجاج البلدي سريع التريش لكنهما لم يختلفا معنويا فيما يخص بقع الدم (BS) ودرجة لون الصفار (YC). كذلك لم تظهر فروقات معنوية بين الليجهورن والبلدي بطئ التريش فيما يتعلق بسمك القشرة (ST) لكن الدجاج البلدي البطئ (SB) كان الأعلى معنويا ($P < .05$)بالنسبة لبقع الدم (BS).