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Effect of Salicornia bigelovii Torr Meal and Age on Egg Quality Characteristics of Baladi and Leghorn Laying Hens

A.A.Alsobayel, H.A. Al-Batshan and M.A. Albadry
Department of Animal Production, College of Agriculture, King Saud University, P.O. Box 2460. Riyadh, Saudi Arabia

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Abstract. The study was undertaken to assess the effect of the inclusion of Salicornia bigelovii Torr meal (SM) in laying ration and age on egg quality characteristics of Baladi and Leghorn hens. Hens were fed ration containing 0, 40 or 80 g kg^{-1} SM. Four eggs per day of each replicate of both breeds were collected for three consecutive days during the last week of each 28-days period. Shell thickness (ST), egg surface area (SA), shell density (SD), shell weight per unit of surface area (SWUSA), Haugh unit (HU), blood (BS) and meat (MS) spots and yolk color (YC) of each individual egg were determined. The inclusion of SM in the layer ration had a significant ($P < .05$) adverse effect upon SH, SA, SWUSA and YC but led to a significant ($P <.05$) increase in HU and decline in MS whereas SD and BS spots were not affected. The increase in HU was more pronounced with respect to the high SM level whereas the decrease in SH and SWUSA was more pronounced with respect to the low SM level. Differences in breeds' response to SM inclusion in the ration was also observed with regard to ST and SWUSA. The results also showed breed and age differences ($P < .05$) with regard to all studied egg and shell quality traits except breed effect with respect to shell thickness and density and age effect with respect to blood and meat spots.

Introduction

Limited resources of standard feed ingredients for poultry in certain countries has necessitated a continual search for alternative feed ingredients. Salicornia bigelovii Torr is a halophytic oil seed crop tolerant of brackish and seawater irrigation. Yield of seed and biomass equaled or exceeded conventional oil-seed crops such as soybean and sunflower [1]. Salicornia bigelovii Torr meal is a by-product of the oil extraction containing 34% protein and 5.5% residual oil [2]. Inclusion of Salicornia bigelovii Torr meal (SM) in the diet has been found to exert a depressing effect upon broiler performance as reported by several investigators [2-4]. With respect to layers performance, similar results were observed by Al-Batshan *et al*. [5]. Alsobayel *et al*. [6] also found similar effect with respect to egg and egg components weights, except albumen weight. SM contained an antinutritinal factor (saponin) which has an adverse effect upon broilers and layers performance and also egg components weights [2-6]. However, the information about its effect upon shell and egg quality characteristics is lacking. Shell and egg quality characteristics have been shown to be influenced by genotype and age. Several investigators reported significant genotype differences with respect to shell thickness [7 - 11], egg surface area [11, 12] and shell weight per unit of surface area [8, 11- 14] but shell density was not affected as reported by Hassanin [11]. Shell thickness [11,15-17], shell weight per unit of surface area [11,13,16] and shell density [11] decreased with advancing age whereas egg surface area increased [11, 18]. However, Izat *et al*. [16] reported no significant age effect upon shell weight per unit of surface area and shell density. Genotype differences were also found by several investigators with respect to Haugh unit values [7, 9, 11, 19- 21], yolk color [11, 22, 23] and blood and meat spots [24 - 27]. On the other hand, Hassanin, [11] did not find genotype differences with respect to blood and meat spots. Similar results were found by Prasad *et al*. [28] and Hamilton [7] with regard to yolk color and blood and meat spots, respectively. Haugh unit values decreased with advancing age [17, 29 - 32] whereas yolk color and meat spots were also affected by age [11, 17] and also blood spots as reported by Alsobayel et al. [17]. The objective of this study is to assess the effect of SM meal and age upon shell and egg quality characteristics of Baladi and Leghorn laying hens which have been bred under local conditions for several generations.

Material and Methods

Two hundreds seventy 40-weeks-old Saudi Arabian Baladi (BL) and Leghorn (L) hens (135 hens of each breed) were obtained from the Baladi and Leghorn Populations which have been randomly bred for several years in the Experimental Poultry and Live-Stock farm of the Animal Production Department, College of Agriculture, King Saud University. The hens of each breed were divided into 9 groups, 15 hens in each, and randomly allotted to 9 floor pens (1.5x2m) in an environmentally controlled house. Three groups (replicates) of each breed were randomly assigned to one of the following dietary treatment; a) laying hen basal diet (Table 1); b) basal diet supplemented with 40 g Kg^{-1} Salicornia Bigelovii Torr meal (SM); c) basal diet supplemented with 80 g Kg^{-1} SM. The chemical composition of SM has been previously reported by Attia et al. [3]. The trial lasted for five 28-d age periods and the birds were subjected to standard management practices. For egg quality characteristics study, four eggs per day of each replicate of both breeds were collected for three consecutive days during the last week of each 28 age period (P). Eggs were stored overnight at 10-11 ^{0}C. The next day, the eggs were individually weighed to the nearest 0.1 g, broken-out and the presence of blood (BS) and meat (MS) spots visually determined. Haugh unit values [33] were directly estimated using micrometer adjustable to egg weight and directly gives Haugh unit value [34]. Yolk color (Y) was measured by Roch Color Scale which has 15 color gradation from very pale to deep yellow [35]. The shell was washed carefully to remove albumen, and dried at 21-24 C^0 for 24h and individually weighed

(SW) to the nearest .01 gm. Shell thickness (ST), expressed in millimeter x 100 was obtained at three locations, middle and both side of each egg without membrane using dial touch micrometer. Egg surface area (SA) in cm^2 was calculated for each egg using the following equation suggested by Nordstorm and Qusterhout [36].

$$SA = 3.9782 x Egg\ Weight^{0.7056}$$

Shell density (SD) in gm/cm^2 was estimated for each egg using the following equation [8].

$$SD = SW(gm)/SA(cm^2) x\ ST(cm)$$

Shell weight per unit of surface area (SWUSA) was also determined using the following equation [36].

$$SWUSA = Shell\ weight\ (mg) / Surface\ Area\ (cm^2)$$

Table 1. composition of the basal diet

Ingredients and calculated analysis	$g\ Kg^{-1}$
Ingredient	
Ground yellow corn	100.0
Soybean meal	141.1
Ground wheat	515.7
Fish meal	21.0
Bran meal	80.0
Alfalfa meal	11.0
Limestone	99.0
Dicalcium phosphate	9.5
Concentrate [a]	4.0
Palm oil	11.0
Pigments [b]	3.7
Salt (NaCl)	2.4
Enzyme preparation[c]	1.0
DL-Methionine	0.6
Calculated analysis	
Crude Protein	170.0
Me_n (Kcal g^{-1})	2.70
Ether extract	30.0
Calcium	35.0
Phosphorus	6.0
Sodium	3.5

[a]Provided the following per Kilogram of diet: vitaminA,12000IU; vitamin D_3, 6000 ICU; vitamin E, 8mg; choline chloride, 20 mg; vitamin K, 1.6 mg; vitamin $B_{1,}$ 1.6 mg; vitamin B_2, 4mg; vitamin B_6, 0.8 mg; niacin, 20 mg, pantothenic acid, 8mg; folic acid, 0.8 mg; biotin, 0.08 mg; vitamin C,80 mg; ethoxyquin, 56 mg; Cu 12 mg; I,0.8 mg; Fe, 40 mg; Mn, 80 mg; Zn, 48 mg; Co,.04 mg; Se, 0.16 mg.
[b]Provided the following per Kilogram of diet: xanthophyls 1.15^{-4} mg; ethoxyquin 2.3^{-4} mg; emulsified fat, 9.55^{-3} mg; silica, 6.21^{-3} mg; carrier, 6.9^{-3} mg.
[C]Xylanase (EC 3.2.1.8) 12000 fxu/g; $^{B-}$ glucanase (EC 3.2.1.6) 5000 bgu/g.

Data obtained were subjected to statistical analysis using the General Linear Models procedures of SAS Institute [37] using the following statistical model:

$$Y_{ijkl} = \mu + B_i + A_j + T_k + BA_{ij} + BT_{ik} + AT_{jk} + BAT_{ijk} + e_{ijkl}$$

where Yijkl is the l^{th} observation of the i^{th} breed (B), j^{th} age period (A) and k^{th} treatment (T). BA_{ij} is the interaction between breed and age, BT_{ik} is the interaction between breed and treatment, AT_{jk} is the interaction between age and treatment and BAT_{ijk} is the interaction between breed, age and treatment. μ is the general mean and e_{ijkl} is the random error associated with Y_{ijkl} observation. Shell, albumen and yolk weight percentages were transformed to arc sin $\sqrt{\ }$ proportion prior to statistical analysis and all three way interactions were neglected.

Results and Discussion

As it is shown in Table 2 age and treatment had a significant (P < .05) effect upon all studied traits except SD with respect to treatment, whereas genotype significantly (P < .05) affected only SA and SWUSA. Signifgicant (P < .05) effects of BxT on ST and SWUSA and of PxT on SD were also observed.

Table 2. Effect of Salicornia bigelovii Torr meal and age on shell thickness (ST), egg surface area (SA), shell density (SD) and shell weight per unit of surface area(SWUSA) of baladi and leghorn laying hens.

	EW	**ST (mmx100)**	**SA (cm^2)**	**SD (g/cm^3)**	**SWUSA (mg/cm^2)**
Genotype (G)	**	NS	**	NS	**
Baladi (BL)	45.47^{B}	37.75	58.77^{A}	2.032	76.42^{A}
Leghorn (L)	53.13^{A}	37.40	65.59^{B}	2.020	75.32^{B}
Age period (P)	**	**	**	**	**
1	48.49^{B}	41.72^{A}	61.46^{A}	1.889^{A}	78.70^{A}
2	49.19^{A}	37.63^{B}	62.08^{B}	2.055^{B}	77.18^{B}
3	49.47^{A}	37.24^{B}	62.34^{B}	2.068^{B}	76.84^{B}
4	49.67^{A}	36.00^{C}	62.51^{B}	2.067^{B}	74.36^{C}
5	49.69^{A}	35.28^{D}	62.53^{B}	2.052^{B}	72.27^{D}
SM level g kg^{-1} (T)	**	**	**	NS	**
0	49.85^{A}	38.17^{A}	62.67^{A}	2.029	77.23^{A}
40	49.18^{B}	36.99^{B}	62.08^{B}	2.014	74.17^{B}
80	48.87^{B}	37.56^{C}	61.80^{B}	2.036	76.20^{C}
B × P	NS.	NS.	NS.	NS.	NS.
B × T	NS.	*	NS.	NS.	**
P × T	NS.	NS.	NS.	**	NS.
B × P × T	NS.	NS.	NS.	NS.	NS.
SEM	± 0.1046	±0.097	± 0.0930	± 0.0038	± 1.3015

* significant (P< .05). ** highly significant (P< .01).
NS nonsignificant.
Means in the same column with different superscripts letter differ significantly (P< .05).

Baladi had significantly (P< .05) smaller SA and higher SWUSA than Leghorn but both have statistically similar STand SD (Table 2). Several investigators reported similar genotypes differences with respect to SA [11, 12] and SWUSA [8, 11-14] but different results than our results with regard to ST [7-11] and SD [12]. SA and SD increased significantly ($P < .05$) following the the first age period and thereafter remained statistically unchanged whereas ST and SWUSA significantly ($P<.05$) decreased with advancing age (Table 2). Similarly was reported by several investigators with respect to ST [11, 15-17], SWUSA [11,13,16] and SA [11,18]. On the opposite to our result Hassanin [11] obseved a decrease in SD with advancing age. The inclusion of 40 or 80 g kg^{-1} SM led to a significant ($P < .05$) decrease in ST, SA and SWUSA compared with the control (Table 2). However, the adverse effect of the low SM level was more pronounced with respect to ST and SWUSA but both level have statistically similar effect upon SA. As it is shown in Figs. 1and 2., the low SM level had a significant ($P < .05$) and more pronounced adverse effect upon ST and SWUSA of Leghorn compared with Baladi whereas both breeds similarly responded to the high SM level with respect to ST and SWUSA.

The less pronounced adverse effect of the high SM level upon ST and SWUSA might be attributed, among other reasons, to the fact that hens received the high SM level produced less number of eggs compared to those received the low SM level as reported by Al-Batshan *et al*. [5] and partially to the high mineral content of SM, particularly calcium, compared to soybean meal as reported by Attia *et al*. [3]. The high mineral content of SM might also have forced the hens to increase their water intake at the expense of their feed intake. However, Al-Batshan *et al.* [5] also reported a signficant decrease in plasma cholesterol of Baladi hens when SM was included in the layer ration at 40 or 80 g Kg^{-1} and only the higher level had an adverse effect upon body weight and feed intake but livablity was not affected. Fig. 3. indicates that only the low SM level had a significant ($P < .05$) adverse effect upon SD during the first age period compared with the control thereafter the low and high SM levels had similar effect.

Table 3 shows that genotype and treatment had a significant ($P<.05$) effect upon all studied traits except BS with regard to treatment whereas the effect of age was significant ($P<.05$) only with respect to HU and YC. Significant effects of BxP on HU and of BxP, BxT and PxT on YC were also observed. Baladi had significantly ($P<.05$) lower HU and YC and higher BS and MS than Leghorn (Table 3). Similar genotype differences were reported by many investigators with respect to HU [7, 9, 11, 19-21], YC [11, 22, 23], BS and MS [24-27]. Opposite to our results, Hassanin [11] and Hamilton [7] did not observe genotype differences with respect to BS and MS and similarly found Prasad *et al*. [28] with regard to YC. HU and YC decreased significantly ($P < .05$) with advancing age whereas BS and MS were not affected (Table 3). Similar was found by many investigators with respect to HU [17, 29-32] and YC [11,17]. Opposite to our results, age was found by Hassanin [11] to affect MS and BS and MS by Alsobayel *et al*. [17]. The inclusion of 40 or 80 g kg^{-1} SM led to a significant (P .05) and equal decrease in MS and YC whereas only the high SM level led to a significant increase in HU. BS was not affected by any SM level but tended to decrease compared with the control. Figs. 4 and 5 show that Baladi had significantly ($P < .05$) lower HU

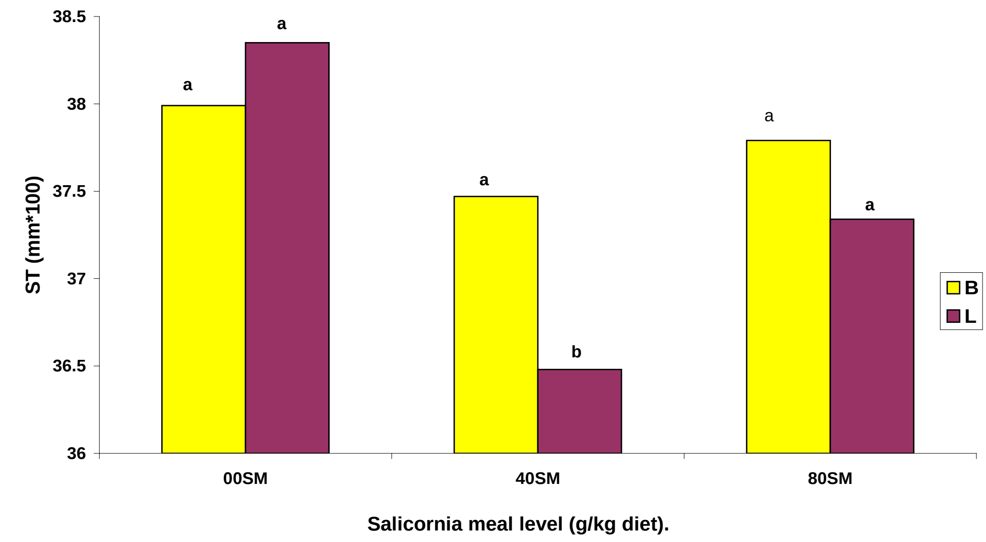

Fig. 1. Effect of BxT on shell thickness(ST) of baladi(B) and leghorn (L).

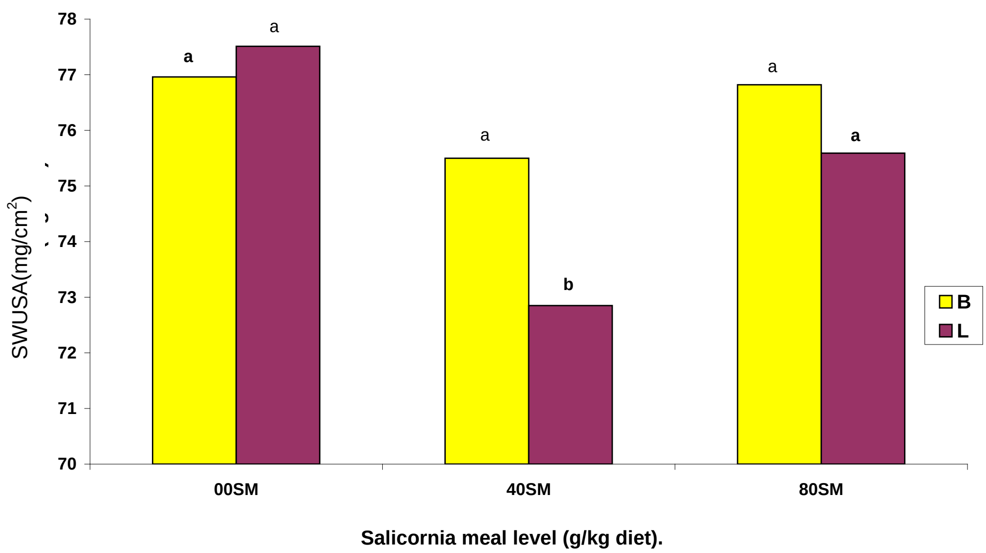

Fig. 2. Effect of B x T on shell weight per unit of surface area (SWUSA) of baladi (B) and leghorn (L)

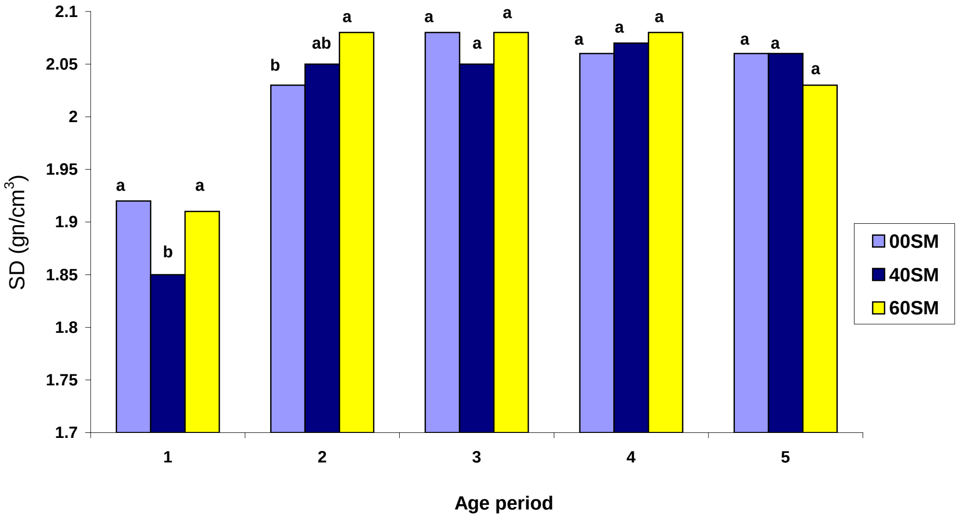

Fig. 3. Effect of P x T on shell density (SD) of baladi (B) and leghorn (L).

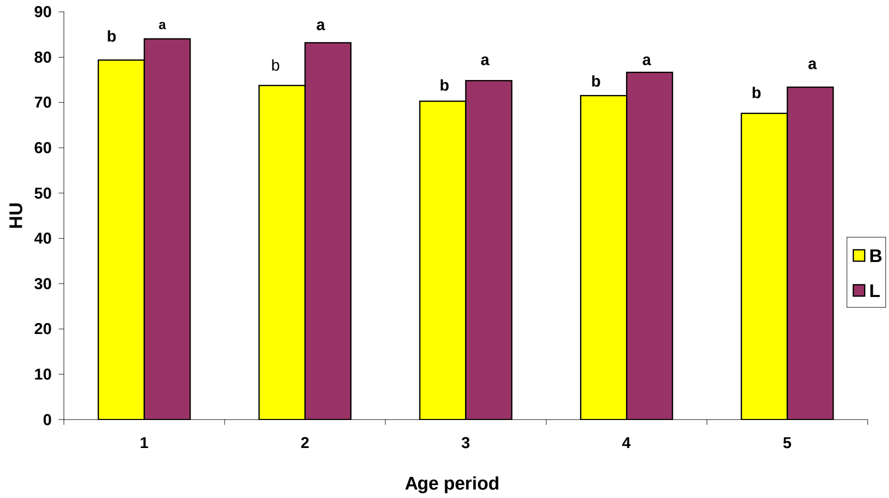

Fig. 4. Effect of B x P on Haugh unit (HU of baladi (B) and leghorn (L).

during all of the age periods and YC during the second and last periods compared to Leghorn.Fig. 6 shows that Baladi and Leghorn responded similarly to the SM level with regard to YC. Fig.7. indicates that the high SM level adversely ($P < .05$) affected YC during the first and fourth age periods and the low SM level during the third age period whereas both breeds responded similarly to the low and high SM levels with respect to YC (Fig.7.).

Table 3. Effect of Salicornia bigelovii Torr meal and age on haugh unit values (HU), blood (BS) and meat (MS) spots and yolk color grades (YC) of baladi and leghorn laying hens

	HU	BS (%)	MS (%)	YC
Genotype (G)	**	*	**	**
Baladi (BL)	72.49 ^{B}	5.038 ^{a}	16.821 ^{A}	4.70 ^{B}
Leghorn (L)	78.41 ^{A}	2.598 ^{b}	10.392 ^{B}	4.91 ^{A}
Age period (P)	**	NS	NS	**
1	81.70 ^{A}	5.09	11.11	5.96 ^{A}
2	78.45 ^{B}	2.78	15.28	5.43 ^{B}
3	72.55 ^{C}	4.17	15.28	4.17 ^{C}
4	74.08 ^{D}	3.28	14.60	3.22 ^{D}
5	70.47 ^{E}	3.77	11.76	5.24 ^{E}
SM level g kg^{-1} (T)	**	NS	*	**
00	74.39 ^{A}	4.19	17.01 ^{a}	5.27 ^{A}
40	74.45 ^{A}	3.91	13.38 ^{b}	4.58 ^{B}
80	77.52 ^{B}	3.36	10.43 ^{b}	4.57 ^{B}
B × P	**	NS	NS	**
B × T	NS	NS	NS	**
P × T	NS	NS	NS	**
B × P × T	NS	NS	NS	**
SEM	± 0.2129	±0.59	±1.04	± 0.0274

[*] significant ($P< .05$).
[**] highly significant ($P< .01$).
[NS] nonsignificant.
Means in the same column with different superscripts letter differ significantly ($P< .05$).

From the results reported herein, we conclude that inclusion of SM in the layer ration had an adverse effect , mainly upon shell quality whereas HU and MS were positively affected. However, according to the chemical analysis reported by Attia et al. [2], SM could be a valuable protein source if there is a feasible way to deactivate the antinutritonal factors. The results also showed breed and age differences with regard to most studied egg and shell quality traits.

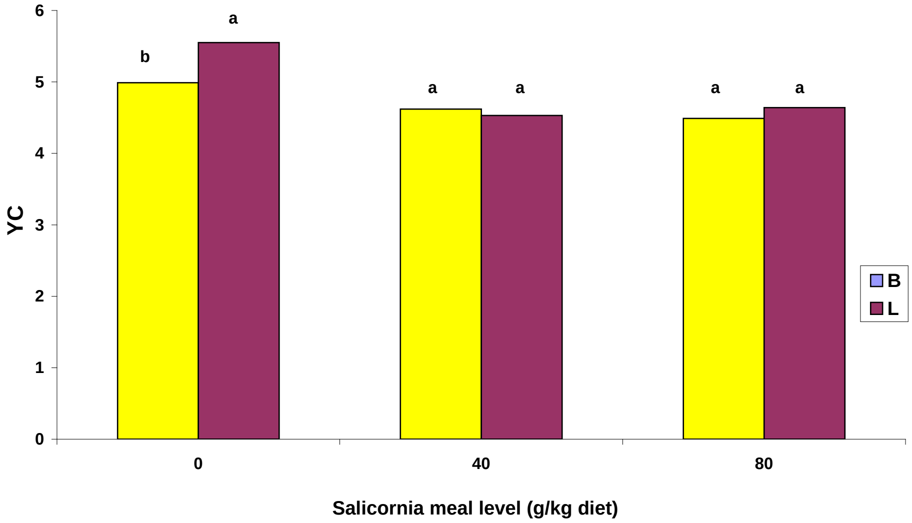

Fig. 6. Effect of B x T on yolk color (YC) of baladi (B) and leghorn (L).

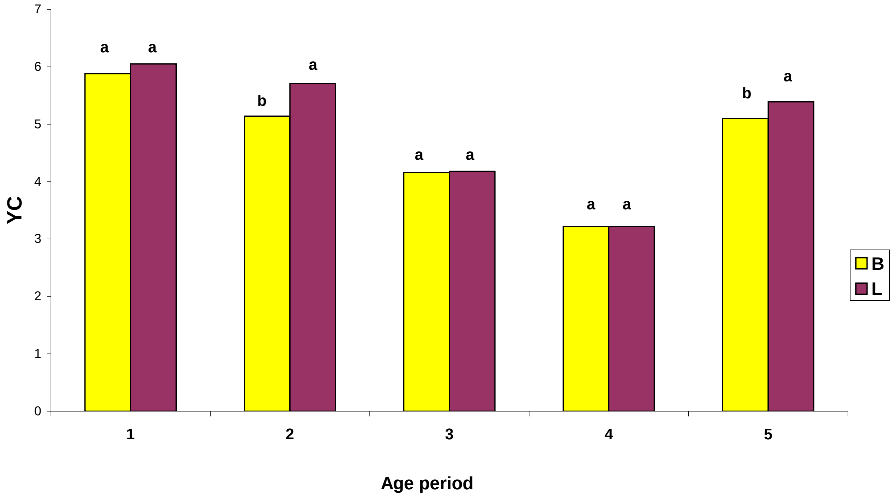

Fig. 5. Effect of B x P on yolk color (YC) of baladi (B) and leghorn (L).

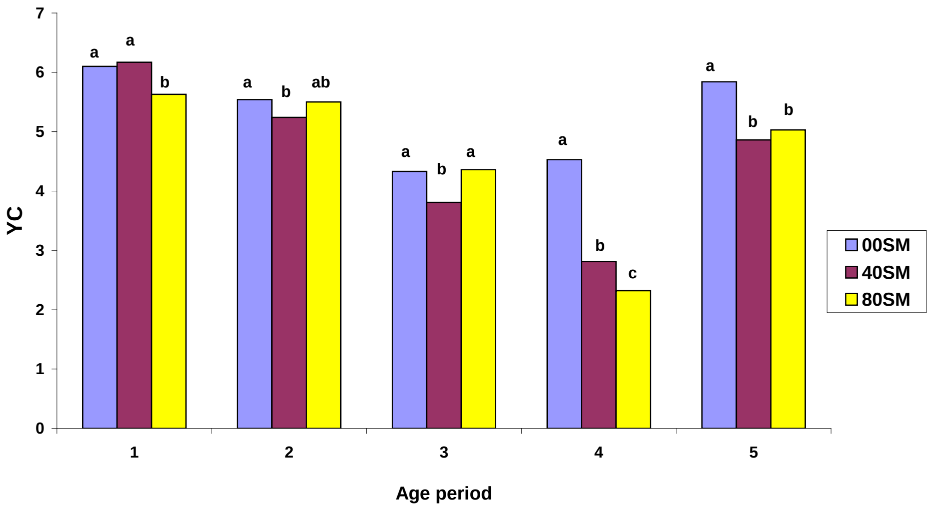

Fig. 7. Effect of P x T on yolk color (YC) of baladi (B) and leghorn (L).

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تأثير كسب السليكورنيا والعمر في جودة صفات يبض الدجاج البلدي والليجهورن

عبد الله العلي السبيل، حمد العبد العزيز البطشان ومحمد أحمد البدري

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ملخص البحث. أجريت هذه الدراسة لتقويم تأثير إضافة كسب السليكورنيا والعمر علي مواصفات بيض الدجاج البلدي والليجهورن. غذيت الطيور على عليقه تحتوي على ٠، ٤٠ أو ٨٠ جم كجم$^{-1}$ كسب سليكورنيا. تم جمع عدد أربع بيضات من كل مكررة في ثلاثة أيام متتابعة خلال الأسبوع الأخير من كل فترة عمريه (٢٨ يوما)، وتم تقدير سمك القشرة، ومساحة سطح القشرة، ووزن وحدة مساحة القشرة ووحدات هاو، وكذلك بقع الدم واللحم ودرجة لون الصفار لكل بيضة.

تشير الدراسة إلى أن إضافة كسب السليكورنيا إلى عليقه الدجاج البياض كان له تأثير سلبي معنوي (P > ٠،٠٥) على سمك القشرة، ومساحة سطح القشرة، ووزن وحدة مساحة القشرة ودرجة لون الصفار، وبالعكس أدى إلى زيادة معنوية (P > ٠،٠٥) في وحدات هاو وانخفاض معنوي في بقع اللحم لكن بقع الدم وكثافة القشرة لم تتأثر بهذه المعاملة، وقد لوحظ أن الزيادة في وحدات هاو والانخفاض في سمك القشرة، ومساحة سطح القشرة يتناسب طرديا مع مستوى كسب السليكورنيا المضاف إلى العليقه، كذلك تشير الدراسة إلى وجود اختلافات معنوية (P > ٠،٠٥) تعود إلى السلالة في التجاوب مع المعاملة فيما يخص سمك القشرة، ومساحة سطح القشرة، بالإضافة إلى ذلك وجدت اختلافات معنوية (P > ٠،٠٥) تعود إلى السلالة والعمر بالنسبة لجميع الصفات المدروسة ما عدا تأثير السلالة على سمك وكثافة القشرة وتأثير العمر على بقع الدم واللحم.