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Influence of Protein Rearing Regimens and Age on Egg Quality Characteristics of Saudi Arabian Baladi Hens

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Abstract. Eggs used in this study were obtained from 465 Saudi Arabian Baladi Hens. The birds were subjected to four different protein rearing regimens: conventional (C), reverse protein (RP) 12% CP from 1 to 6 wks, followed by 15% CP up to 14 wks and 18% CP diet from 14–20 wks of age, single stage low protein (SS_1) 15% CP and (SS_2) 12% CP diets from 1-20 wks of age. All the experimental groups received a conventional 18% CP diet during the first week of age and were offered a commercial layer ration during the laying period.

A total of 120 eggs, whenever possible, of each experimental group was collected over the three consecutive days of each month for a production period of twelve months. The eggs were examined for weight, Haugh units, shell thickness, shape index, incidence of blood and meat spots and yolk pigmentation.

The results indicated a significant protein rearing regimen ($P \leq .01$) effect upon egg weight, Haugh units and shell thickness. Egg weight was adversely affected by RP, SS_1 and SS_2 while Haugh units were similarly influenced by SS_1 and SS_2. RP and SS_2 also appeared to have a detrimental effect on shell thickness. Shape index, incidence of blood and meat spots and yolk pigmentation were not significantly affected by the protein rearing regimens. Overall hen day egg production, feed intake/bird and feed consumed/dozen eggs also did not differ significantly among any treatment. However, the C group had significantly ($P \leq .05$) lower livability than the SS_1 group.

Age had a significant ($P \leq .01$) effect upon all studied egg quality traits. Egg weight increased while Haugh units and shell thickness decreased with increasing age. Shape index decreased during the first four months of lay then started to increase in the fifth month of the laying period. Blood spots increased with age, while meat spots and yolk pigmentation varied greatly from one age period to another.

Introduction

Reports on the effect of protein rearing regimens on subsequent egg quality characteristics have been inconsistent. Reverse protein reduced egg weight [1-3], Haugh units [3] and shell quality [1]. Contrary to this, Leeson and Summers [4], Bish *et al.* [5] and Robinson *et al.* [6] reported no detrimental effect attributed to reverse protein diets on egg quality characteristics. Single stage low protein diets also seem to

have no adverse effect upon egg quality characteristics as reported by Leeson and Summers [4] and Maurice *et al.* [2] who used 14 and 13.5% CP for the entire rearing period respectively. Similar results were reported for egg weight when 12% CP diet was fed for the whole rearing period [7]. Moreover, Maurice *et al.* [2] reported egg weight increase due to low protein rearing diets.

Informations on the effect of protein rearing regimens on incidence of meat and blood spots, shape index and yolk pigmentation are lacking.

Age of the hen seems to play an important role in determining egg weight, Haugh units and shell quality. Egg weight increases [8-9, 10, pp. 92-108, 11-14] while Haugh units decrease [14-17] with increasing age. Shell thickness also tended to decrease with age [8, 13, 18, 19]. Egg shape index has been shown to vary according to strain of bird, size of egg, position of the egg in the clutch [8, 20, 21] and the time of oviposition [22]. Benjamin [20] reported that shape index increased until the fifth or sixth month of production then decreased gradually. Marble [21] found no significant seasonal variation in shape indices of eggs laid by Plymouth Rocks. Mueller *et al.* [23] reported that eggs laid during the second year of production had significantly lower shape indices than eggs laid during the first year of production, but there was no significant seasonal effect on egg shape. Blood and meat spots incidence appear to be influenced by age of the hen. Nalbandov and Card [24] found the highest percentage of defects during the first laying year and the lowest during the third laying year and a great individual variation in this respect. Jeffrey [25] reported that blood and red meat spots were most numerous at the start of the laying year, whereas pale meat spots increased in frequency during the laying year. Intensity of yolk pigmentation has been atributed to wide variation of xanthophylls content in feed source, their availability, oxidation upon storage and other dietary and health factors [26]. The genetic ability to absorb and deposit xanthophyll in the egg yolk has been also found to vary among individual hens within a single strain [27], between breeds [28] and strains [26]. Janky [29] observed that pigmentation became paler and less intense from January to October then increased from October to December.

The objectives of this study were to assess in Saudi Arabian Baladi Hens; 1) the effect of protein rearing regimens and age on egg quality characteristics and 2) the effect of protein rearing regimens on overall egg laying performance.

Materials and Methods

Eggs used in this study were obtained form 465 Saudi Arabian Baladi hens which have been subjected to four different protein rearing regimens: Conventional (C) [30] reverse protein (RP), 12% CP from 1-8 wks followed by 15% CP up to 14 wks and 18% CP from 14-20 wks of age; single stage low protein 15% CP (SS_1) and single stage low protein 12% CP (SS_2) from 1-20 wks of age. All the birds received the con-

ventional 18% CP during the first week of age and were offered a commercial layer ration containing 17% CP and 2695 M.E. kcal/kg during the laying period. The birds were divided into four experimental groups, four replicates in each and were grown under normal management practices. However, details regarding rations ingredients and nutrients composition, photoperiods and housing of birds are outlined elsewhere [31]. Egg production, mortality and feed intake per pen were recorded. Overall hen day egg production, livability, feed intake and feed consumed per dozen eggs, were calculated.

Egg quality studies started April 1988, when the birds were 5 months old. Thirty eggs from each pen, whenever possible, were collected over three consecutive days at the second week of each month for a production period of twelve months. The eggs collected were left overnight in the laying house. On the second day, eggs were individually weighed to the nearest .01g, broken-out and the presence of blood and meat spots visually determined. Haugh unit values [32] were directly estimated using micrometer adjustable to egg weight and directly gives Haugh unit value [33]. Yolk color was measured by Rock Color Scale which has 15 color gradations from very pale to deep yellow [34]. Shell thickness, expressed in millimeter × 100 was obtained at three locations: middle and both sides of each egg without membranes using dial touch micrometer. The shape index (width/length × 100) for each egg was also calculated.

Data collected were subjected to statistical analysis using SAS general linear model procedure, KSU Computer Center, according to the following statistical model,

$$Y_{ijk} = U + T_i + A_j + TA_{ij} + e_{ijk}$$

where the Y_{ijk} is the k^{th} observation of the i_{th} treatment and j_{th} age period. U is the general mean and e_{ijk} is the random error associated with Y_{ijk} observation [35].

Results and Discussion

As it is indicated in Table 1 protein rearing regimens had a significant ($P \leq .01$) effect upon egg weight, Haugh units and shell thickness. Eggs produced by the C group had significantly ($P \leq .01$) the highest weight followed by those of RP and SS_1, while SS_2 group had the lowest weight. Similar results have been reported by Leeson and Summers [1], Maurice *et al.* [2] and Doran *et al.* [3] for reverse protein fed birds. On the contrary, Leeson and Summers [4], Bish *et al.* [5] and Robinson *et al.* [6] reported no detrimental reverse protein effect on egg weight. Similar findings were reported for single stage low protein diets [2, 4, 7]. With respect to Haugh unit values, results showed that the C and RP groups had significantly ($P \leq .01$) higher Haugh unit values than SS_1 while SS_2 had lower Haugh unit values than C group

(Table 1). These results disagree with that of Doran *et al.* [3] who reported lower Haugh unit values for reverse protein fed birds. On the other hand Leeson and Summers [4], Bish *et al.* [5] and Robinson *et al.* [6] did not detect any significant differences in Haugh units attributed to protein rearing regimens.

Table 1. Effect of protein rearing regimens and age on weight (W), Haugh units (HU), shell thickness (SH) and shape index (SI) of eggs laid by Saudi Arabian Baladi hens.

Parameter	n	W (g) $\bar{X} \pm$ S.E.	HU values $\bar{X} \pm$ S.E.	SH (mm × 100) $\bar{X} \pm$ S.E.	SI (W/L × 100) $\bar{X} \pm$ S.E.
Treatment (T)		**	**	**	n.s.
C	1366	$46.05 \pm .10^{A}$	$73.02 \pm .23^{A}$	$34.03 \pm .08^{A}$	$74.04 \pm .11$
RP	1313	$45.26 \pm .11^{B}$	$72.67 \pm .24^{AC}$	$33.50 \pm .09^{B}$	$74.02 \pm .12$
SS_1	1355	$45.12 \pm .10^{B}$	$71.69 \pm .23^{B}$	$33.99 \pm .09^{A}$	$73.98 \pm .11$
SS_2	1371	$44.31 \pm .10^{C}$	$72.18 \pm .28^{BC}$	$33.52 \pm .08^{B}$	$73.88 \pm .11$
Age (A)		**	**	**	**
T × A		**	**	**	n.s.
Overall mean		$45.03 \pm .05$	$72.38 \pm .12$	$33.38 \pm .04$	$73.98 \pm .06$

** Significantly different ($P \leq 0.01$)
n.s. Nonsignificant.
Means in the same column with different superscripts differ significantly ($P \leq 0.01$)

Eggs produced by RP and SS_2 groups had significantly ($P \leq .01$) the lowest shell thickness, while those of SS_1 had similar shell thickness as the C group (Table 1). Similar finding was reported by Leeson and Summers [1] for reverse protein fed birds. Different results, however, were found by Leedon and Summers [4], Maurice *et al.* [2] and Robinson *et al.* [6]. The overall egg weight, Haugh units and shell thickness averages were far less than those reported for standard breeds [9, 34] but slightly higher than those reported by Alsobayel [36] for Saudi Arabian Baladi chickens housed conventionally or in an environmentally controlled house. Blood and meat spots incidence, egg shape index and yolk pigmentation were not significantly influenced by the rearing regimens (Tables 1 and 2). However the reported averages were comparable to those of standard Leghorns [34].

Statistical analysis showed a significant ($P \leq .01$) age effect upon all studied egg quality traits (Tables 1 and 2). Egg weight increases (Fig. 1) while Haugh units decreases (Fig. 2) with increasing age. Similar findings were reported by many investigators on egg weight [8-14] and on Haugh units [14-17]. Fig. 2 shows a sharp Haugh units decrease during the month of August, when the birds were 10 months old. This might be due to other factors such as high house temperature which reached 32°C

Table 2. Effect of protein rearing regimens and age on incidence of blood and meat spots (BS and MS) and yolk color (YC) of eggs laid by Saudi Arabian Baladi hens

Parameter	n	BS (%) $\bar{X}$ ± S.E.	MS (%) $\bar{X}$ ± S.E.	YC values $\bar{X}$ ± S.E.
Treatment (T)		n.s.	n.s.	n.s.
C	1366	5.90 ± .62	7.72 ± .74	6.54 ± .02
RP	1313	5.99 ± .64	7.82 ± .77	6.55 ± .02
SS_1	1355	5.56 ± .62	8.64 ± .74	6.57 ± .02
SS_2	1371	5.65 ± .62	8.07 ± .74	6.56 ± .02
Age (A)		**	**	**
T × A		n.s.	*	**
Overall mean		5.61 ± .31	8.10 ± .37	6.54 ± .01

n.s. Nonsignificant.
* Significantly different ($P \leq 0.05$).
** Significantly different ($P \leq 0.01$).

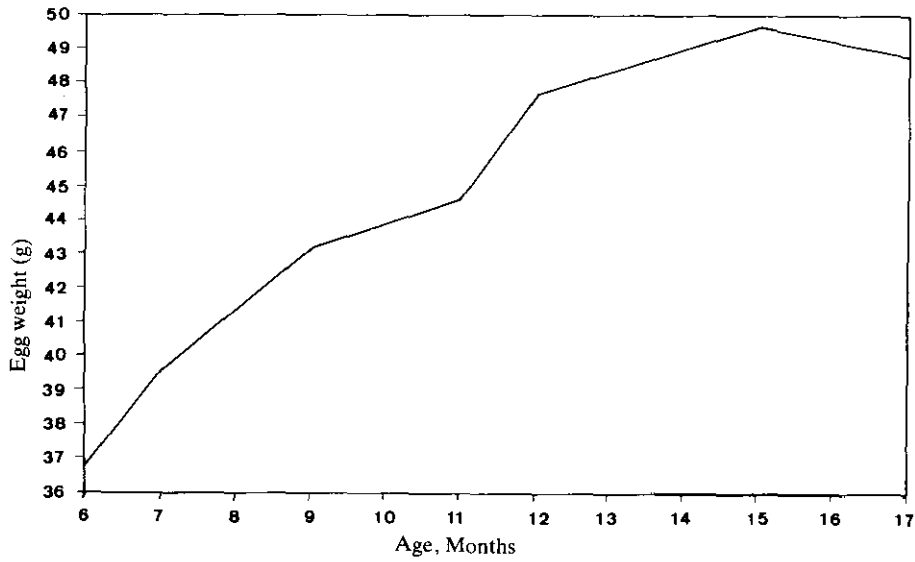

Fig. 1. Average monthly egg weight during 12 months egg production period.

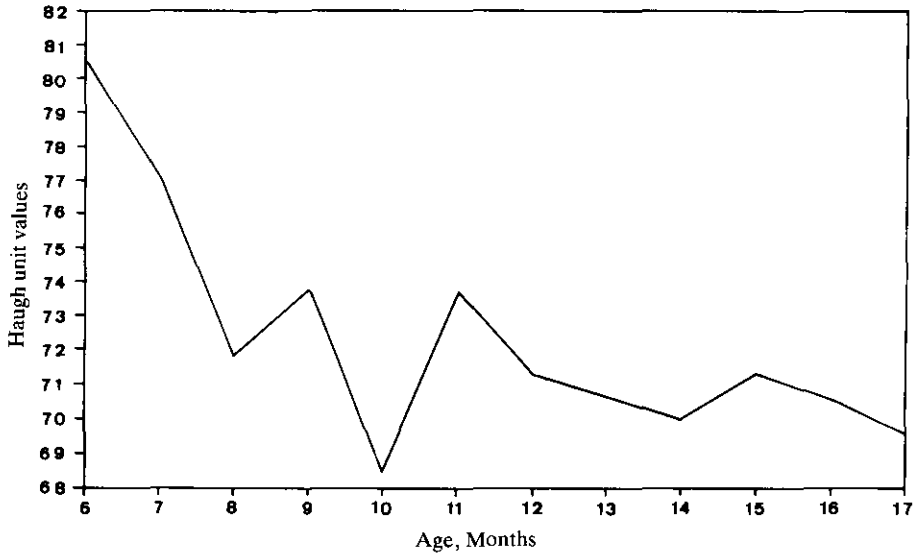

Fig. 2. Average monthly Haugh unit values through 17 months of age

during this period. As it is shown in Fig. 3, shell thickness increased at early age periods and decreased thereafter. However, the sharp decrease during the 11_{th} month of age might be caused by other factors such as seasonal effect which could partially mask the effect of age [18]. In general, shell thickness seems to decrease with age. Similar results were reported by several investigators [8, 13, 18, 19]. Shape index (Fig. 4) decreased during the first four months of the laying period then started to increase, but never reached its starting value. These results disagree with those of Benjamin [20]. Other factors appear to influence egg shape such as strain, size of the egg, position of the egg in the clutch and time of the oviposition [8, 20-22]. Blood spots incidence increased with age while meat spots incidence varied greatly from one age period to another (Fig. 5). Our results disagree with those of Jeffrey [25] in respect to blood spots incidence. The great variability in meat spots incidence might be due to some other factors such as breed, season and other environmental factors. Yolk pigmentaiton (Fig. 6) increased sharply at 10 months of age then dropped to it slowest value at 12 months of age and started thereafter to increase. However many factors were found to influence yolk pigmentation [26-29].

Overall egg production, livability, feed intake and feed consumed per dozen eggs were not adversely influenced by reverse (RP) and signle stage low protein diets (Table 3). Similar results were reported by many investigators [1-7]. Less feed intake [1], lower mortality [2] and higher feed consumed /dozen eggs [5] have been reported for reverse protein fed birds. In our study, RP group tended to have higher feed

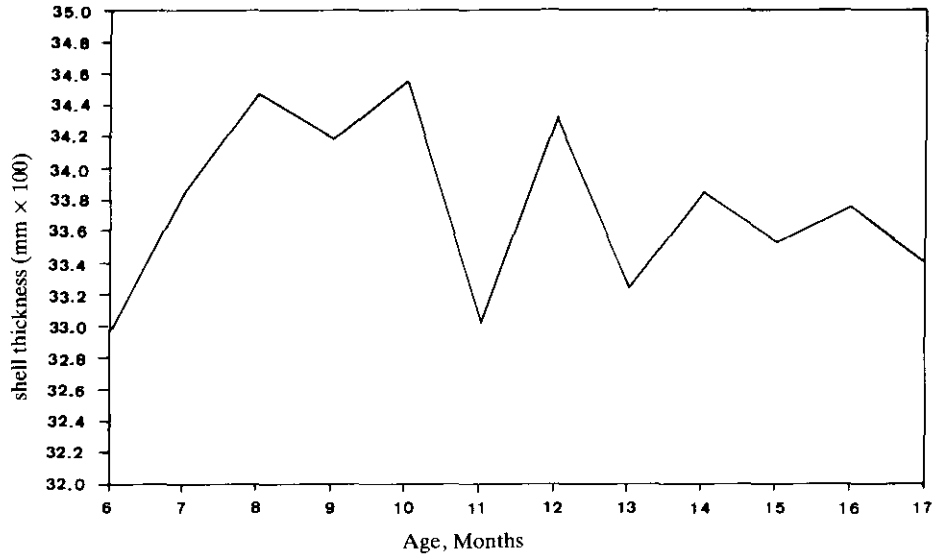

Fig. 3. Average monthly shell thickness through 17 months of age.

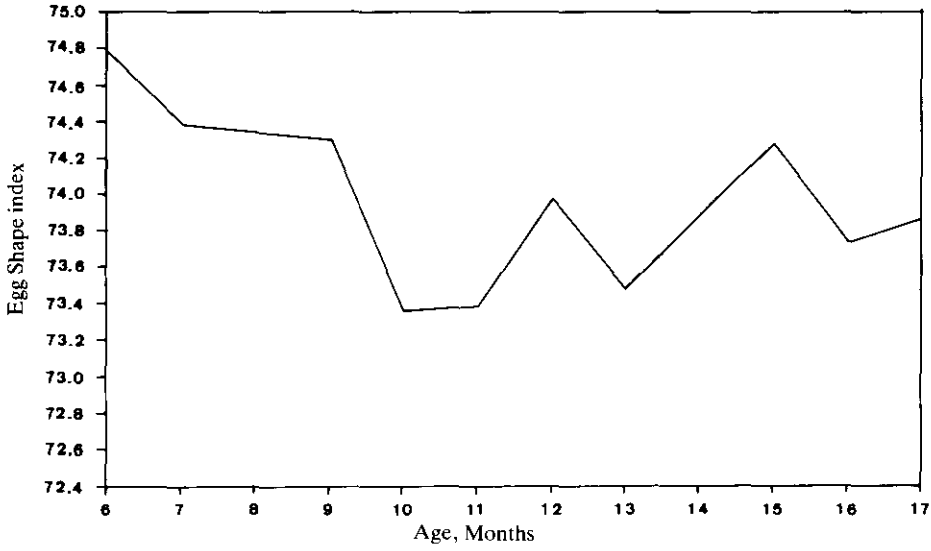

Fig. 4. Average monthly egg shape index through 17 months of age.

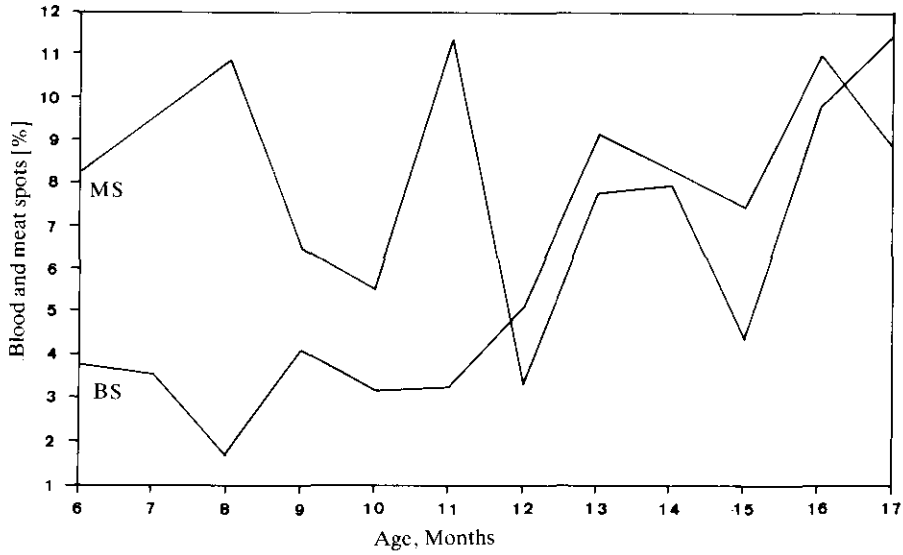

Fig. 5. Average monthly blood and meat spots incidence through 17 months of age.

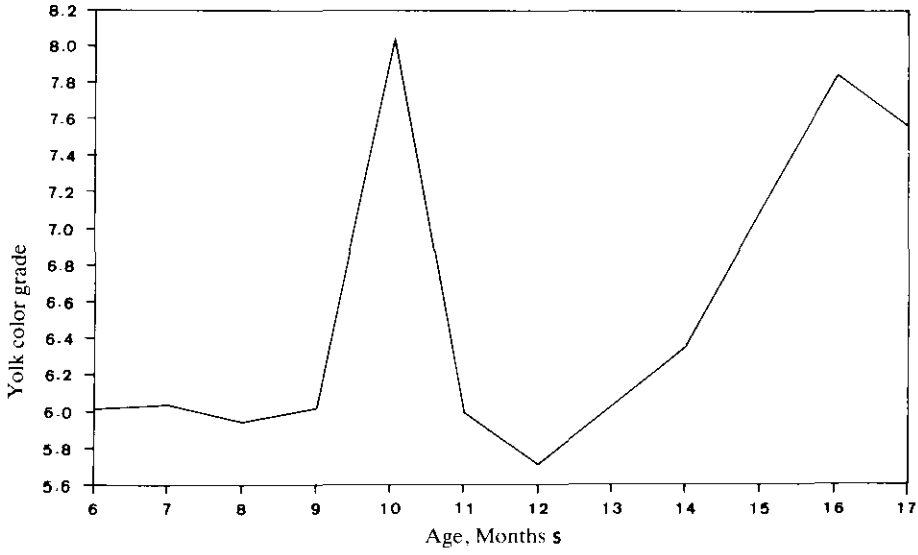

Fig. 6. Average monthly grade of yolk color through 17 months of age

Table 3. Effect of protein rearing regimens on overall hen-day egg production (HD), daily feed intake/bird (FB), livability (L) and feed consumed/ dozen egs (FC) of Saudi Arabian Baladi hens

Parameter	HD (%) $\bar{X}$ ± S.E.	FB (g) $\bar{X}$ ± S.E.	L (%) $\bar{X}$ ± S.E.	FC (kg/dozen) $\bar{X}$ ± S.E.
Treatment (T)	n.s.	n.s.	*	n.s.
C	48.02 ± 2.07	86.45 ± 3.56	91.00 ± .04^{a}	2.16 ± .06
RP	47.02 ± 2.07	88.38 ± 3.56	93.00 ± .04^{ab}	2.33 ± .06
SS_1	48.15 ± 2.07	82.68 ± 3.56	98.00 ± .04^{bc}	2.07 ± .06
SS_2	48.62 ± 2.07	85.45 ± 3.56	97.00 ± .04^{ac}	2.12 ± .06

n.s. Nonsignificant.

* Significantly different ($P \leq 0.05$).

Means in the same column with different superscripts letter differ significantly ($P \leq 0.05$).

intake, lower egg production and to consume more feed/dozen eggs The C group had significantly ($P \leq 0.05$) lower livability compared with SS_1 (Table 3). However, the reason is unknown.

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تأثير بروتين العلقية خلال فترة النمو والعمر على صفات جودة البيض في الدجاج البلدي

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ملخص البحث. جمع البيض المستخدم في هذه الدراسة من عدد ٤٦٥ من الدجاج البلدي التي غذيت على علائق تحتوي على نسب بروتين مختلفة خلال فترة النمو: عليقة تقليدية (C) ، عكس تقليدية (RP) ، ١٢٪ بروتين خام من ١ ـ ٦ أسابيع من العمر، ١٥٪ بروتين خام حتى ١٤ أسبوعًا و ١٨٪ بروتين خام من ١٤ ـ ٢٠ أسبوعًا من العمر، عليقتين منخفضتي البروتين ١٥ ، ١٢٪ SS_1, SS_2 جميع الطيور حصلت على عليقة تقليدية تحتوي على ١٨٪ بروتين خام خلال الأسبوع الأول من العمر وعلى عليقة تجارية خلال فترة الإنتاج.

تم جمع ١٢٠ بيضة، كلما أمكن ذلك، من كل مجموعة تجريبية خلال ثلاثة أيام متتالية من كل شهر بعد ذلك يتم فحص صفات البيض الخارجية والداخلية (الوزن، وحدات هاو، سمك القشرة، شكل البيضة، نسبة وجود بقع الدم واللحم ودرجة لون الصفار).

دلت النتائج على أن بروتين العليقة له تأثير معنوي ($P \leq .01$) على وزن البيض، وحدات هاو وسمك القشرة، حيث كان تأثير كل من RP, SS_1, SS_2 سلبيًا على وزن البيض، كذلك كان تأثير SS_1, SS_2 على وحدات هاو وتأثير RP, SS_2 على سمك القشرة، أما شكل البيضة، نسبة وجود بقع الدم واللحم، درجة لون الصفار، إنتاج البيض، استهلاك العلف وكذلك كمية العلف المستهلكة لإنتاج دستة من البيض فلم تتأثر معنيًا بأي من العلائق المستخدمة. إلا أن حيوية المجموعة (C) كانت أقل معنويًا من حيوية المجموعة SS_1.

كذلك دلت النتائج على أن العمر له تأثير معنوي ($P \leq .01$) على جميع صفات البيض المدروسة، وزاد وزن البيض لكن وحدات هاو وسمك القشرة تناقصا مع تقدم العمر، وقد تناقص شكل البيضة خلال الشهور الأولى من إنتاج البيض ومن ثم بدأ في الزيادة في الشهر الخامس، وازدادت نسبة بقع الدم مع تقدم العمر، لكن اختلفت نسبة بقع اللحم ودرجة لون الصفار بشكل كبير من فترة لأخرى.