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Evaluation of Egg Quality of Japanese Quail in Different Housing Systems

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Abstract

A total of 135 birds of Japanese quails at 5th week of age were divided randomly into three groups housed in galvanized metal cages, pens covered with fine and coarse sawdust for the 1st, 2nd and 3rd groups, respectively. The results revealed that egg length, egg shape index, shell weight, shell ratio and egg thickness were significantly affected by housing system. The egg produced in fine sawdust group had the highest egg shape index (82.75 %), shell weight (1.69 g), shell ratio (15.88 %) and shell thickness (0.27 mm) with lowest egg length (29.98 mm) in fine sawdust group when compared with other systems. On the other hand, egg weight (11.99 g), egg surface area (22.91 cm^2), egg width (25.86 mm) was higher in the cage system with no significant differences. Moreover, the most of internal egg quality was significantly affected by different housing systems, while there were no significant differences in albumin ratio and width, yolk weight and ratio. Threfore, the egg quality (internal and external traits) was better in cage system and deep litter system with fine sawdust in comparison to the deep litter system with coarse sawdust.

Keywords: Housing system, Quail, Egg quality.

Introduction

The Japanese quail (*Coturnix japonica*) is one of the best birds using in researches that characterized by easy maintenance, short generation interval and high egg production [1]. Moreover, the productivity and quality of the eggs in quails are important in an economical breeding and also for the propagation of the flocks. Before, 2000 B.C. the Egyptians are known the quails and represented it as “W” in the alphabet [2]. Eggs of most bird species may have similarities in nutritional composition and potential food usage [3]. However, information on egg quality characteristics and utilization of egg for food and other purposes has been limited mostly to chicken eggs. The egg quality plays the role in the economy, where poor quality causes economic losses in egg industry [4]. Furthermore, the changes in external quality correlated with internal quality of quails [5] and layers [6], hence, cause the main change in egg production [7]. The housing system is an external factor that influences both the performance of hens and the egg quality [8]. There were several studies have been conducted on the effects of different housing systems, such as conventional cage, enriched-cage and outdoor systems on external and internal egg quality characteristics of hens [9,10]. However, there are limited studies evaluating the differences among housing systems for egg quality traits of quails. The findings of Alam *et al*. [11] showed that egg production for quails reared in battery cages was higher than that reared on litter floor, while Arumugam *et al*. [12] found that the fertility level for Japanese quails was not affected by system of rearing. Because of the growing interest in the consumption of quail eggs in our country and due to the lack of recent investigations in this direction, the current study was conducted to evaluate the effect of housing system on egg quality of Japanese quail (*Coturnix japonica*) and the correlation between external and internal quality traits.

Material and methods

A total number of 135 female quails (weight 150-160 g) of five weeks old were collected from Faculty of Agriculture, Zagazig University, Egypt. They were classified into three groups each of 45 birds; group housed in galvanized metal cages, group housed in pens covered with fine sawdust and group housed in pens covered with coarse sawdust. Each group was divided into three replicates (each of 15 birds) and the available area per quail was 0.06 m^2/bird. Laying quails in all groups were fed identical commercial feed mixtures (Table 1),

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which was formulated to meet the nutrient requirements of quails [13], which containing of 20% crude protein, 2.5% calcium and 11.93 MJ/kg metabolized energy that fed two times daily (7 am and 5 pm). Feed and water were provided ad-libitum. The daily light duration consisted of 14 hours light from natural light with 10 hours dark until the end of the study. Ninety quail's eggs (from the 8^{th} until the 10^{th} weeks of age) were collected (30 eggs from each group). The Sartorius 1202 MP balance has been used to measure the weight (g) of whole egg, albumen, yolk and egg shell weight, while electronic digital caliper was used for calculating the whole egg length, width, shell thickness, albumen height and width, yolk height and width (mm) [4]. Ahmed *et al*. [14] calculated the egg shape index through the following equation: egg width/egg length x 100. As well as the egg shell ratio was calculated, shell weight/egg weight x 100. Moreover, Sezer [15] calculated the egg surface area (cm^2) as the following: $3.9782W^{0.7056}$, where W = egg weight. The albumen and yolk ratios were calculated using the individual weight of each egg and the weight of their components [8]. Haugh Unit = 100 log (albumen height + 7.57 - 1.7 x egg weight $^{0.37}$ [16].

One way ANOVA used for analysis the data through a SAS program [17]. Duncan's tests were conducted to determine the differences among the means [18]. The correlation estimates between external and internal quality were done using Pearson correlation.

Table 1: Ingradiants of the experimental diet (kg/100kg)

Ingredient	Kg	Calculated analysis	
Yellow corn	65	Metabolized energy	11.93 MJ/kg
Soybean meal	20	Crude protein	20%
Corn gluten	5.2	Calcium	2.5%
Calcium carbonate & phosphate	2.1		
Soybean oil	0.2		
Premix and common salts	0.7		
Other feed additive	0.6		

Results and Discussion

The changes of egg quality in housing systems (cage, deep litter with fine sawdust and deep litter with coarse sawdust) were showed in Tables 2 and 3, respectively. The results revealed significant differences in most of the external and internal quality. Moreover, the results revealed a significant correlation among the most quality traits (Table 4). Egg weight is an important parameter for overall egg quality and economics [19]. From the obtained results (Table 2), it is clear that egg weight, egg surface area and egg width were higher in cages than other groups, but the differences did not reach the significance. Leyendecker *et al*. [20] stated that egg weight was higher in cage systems than in floor systems or free-range systems. Nerveless, in other studies, heavier eggs were found in litter systems than in cages [21,22]. In the present study, egg length from the cage system was significantly higher than those from the other systems, while the egg shape index was the highest in floor system with fine sawdust with significant differences [19]. The egg shape index was higher in cage-system eggs than in the litter system eggs [23]. Jana *et al*. [24] mentioned that the highest shape index was detected in a cage than litter system. Otherwise, these results disagreed with others [25,26,27] who found that housing system did not affect the egg shape index.

Table 2: Effect of the different housing systems on external egg quality traits of Japanese quail

External egg quality	System of housing			P-Values
	Deep litter with coarse sawdust	Deep litter with fine sawdust	Cage system	
Egg weight (g)	10.96±0.13	10.86±0.82	11.99±0.57	0.331
Egg surface area ($cm^{2)}$	21.51±0.20	21.30±1.08	22.91±0.75	0.289
Egg width (mm)	24.7±0.47	24.80±0.47	25.86±0.45	0.162
Egg length (mm)	31.25±0.54^{ab}	29.98±0.23^{b}	32.42±0.59^{a}	0.005
Egg shape index (%)	79.05±0.81	82.75±1.6	79.84±0.92	0.079
Shell weight (g)	1.08±0.03^{b}	1.69±0.07^{a}	1.66±0.08^{a}	0.000
Shell ratio (%)	9.86±0.25^{c}	15.88±0.79^{a}	13.89±0.32^{b}	0.000
Shell thickness (mm)	0.20±0.01^{b}	0.27±0.01^{a}	0.26±0.01^{a}	0.000

^{abc}Means within the same row having different superscripts were significantly different at P<0.05.

Table 3: Mean ± SE of internal egg quality of quails in relation to different housing systems

Internal egg quality	System of housing			P-Values
	Deep litter with coarse sawdust	Deep litter with fine sawdust	Cage system	
Albumin weight (g)	5.95±0.79 ^{ab}	5.57±0.20 ^{b}	6.31±0.28 ^{a}	0.051
Albumin ratio (%)	54.32±0.89	52.46±2.05	52.80±1.54	0.676
Albumin height (mm)	5.41±0.15 ^{a}	5.15±0.16 ^{ab}	4.86±0.17 ^{b}	0.084
Albumin width (mm)	41.21±0.99	36.35±0.71	40.71±0.96	0.271
Yolk weight (g)	3.93±0.13	3.59±0.63	4.02±0.33	0.750
Yolk ratio (%)	35.81±0.85	31.56±0.81	33.31±0.56	0.305
Yolk height (mm)	9.39±0.25 ^{ab}	9.25±0.20 ^{b}	9.94±0.09 ^{a}	0.047
Yolk width (MM)	21.09±0.39 ^{b}	21.91±0.36 ^{ab}	22.99±0.37 ^{a}	0.005
Haugh unit	94.64±0.79 ^{a}	93.53±0.98 ^{ab}	91.14±1.11 ^{b}	0.049

^{abc} Means within the same row having different superscripts are significantly different at P<0.05.

Egg shell quality is important for economic reasons. Previous studies compared traditional cages with other housing systems and observed thicker egg shells in aviary and barn systems [25]. In the present study, housing systems had a significant effect in egg shell quality, where shell weight, ratio and thickness were the highest in litter system with fine sawdust. These results were disagreed with others [9,19,23] who stated that the housing systems did not affect the egg shell quality. Englmaierova *et al*. [8] compared different housing systems and observed higher shell ratio in aviary eggs than in cages and litter system eggs. El-Sheikh *et al*. [28] mentioned that there was non significant effect of the housing system (cage & floor) on shell percentage and shell thickness with or without membranes.

Data presented in Table (3) showed the effect of housing system on the internal egg quality of Japanese quails. The eggs in cage system had the highest albumin weight, yolk weight and height, while it had the lowest albumin height and Haugh unit in comparison to other systems. On the other hand, Bilgehan *et al*. [19] stated that yolk weight, albumen weight, albumen index and the Haugh unit was higher in the floor system, but were similar to the conventional and enriched cage systems. Samiullah *et al*. [29] and Tůmova *et al*. [30] reported that the eggs Haugh unit in a conventional-cage system was higher than those in a free-range system. However, in other studies there were no differences between housing systems regarding Haugh unit in Japanese quails [23,27]. On the contrary, there were no significant differences in other internal egg quality, which agreed with Abdel-Fatah [31] who found no significant differences in the egg quality between deep-litter system and battery cages.

In the present study, the correlation between internal and external egg quality (Table 4), revealed a positive correlation of egg weight and egg surface area with albumen weight (0.737 and 0.740), yolk weight (0.907 and 0.905), and yolk ratio (0.593 and 0.598), respectively. These results were agreed with Zita *et al*. [32], who found positive correlations of egg weight with yolk weight and albumen weight. Similarly, Minvielle *et al*. [33] detected positive correlations among egg weight, albumen weight and yolk weight. Baumgartner *et al*. [34] mentioned that there was no significance in the correlations between egg weight and the yolk and albumen. On the contrary, Ozcelik [35] found a negative correlation between egg weight and yolk ratio.

Table 4: Correlation coefficients among the external and internal egg quality traits in Japanese quails.

	Egg Weight (g)	Egg Surface Area (cm$^{2)}$	Egg Width (mm)	Egg Length (mm)	Egg shape Index (%)	Shell Weight (g)	Shell Ratio (%)	Shell Thickness (g)
Albumin weight (g)	0.737***	0.740***	0.725***	0.664***	0.125	0.333	-0.229	0.143
Albumin ratio (%)	-0.604***	-0.605***	-0.405***	-0.029	-0.490***	-0.309	0.137	-0.212
Albumin height (mm)	-0.187	-0.187	-0.130	-0.106	-0.039	-0.377*	-0.288	-0.113
Albumin width (mm)	0.232	0.236	0.151	0.305	-0.176	0.004	-0.179	-0.101
Yolk weight (g)	0.907***	0.905***	0.667***	0.301	0.498***	0.284	-0.402*	0.112
Yolk ratio (%)	0.593***	0.598***	0.370*	0.147	0.303	-0.112	-0.608**	-0.076
Yolk height (mm)	0.250	0.259	0.407*	0.328	0.123	0.102	-0.120	0.212
Yolk width (MM)	0.292	0.307	0.444*	0.376*	0.117	0.438	0.248	0.387
Haugh unit	-0.542***	-0.542***	-0.432*	0.298	-0.194	-0.512**	-0.151	-0.194

*significant at P<0.05, **significant at P<0.01 and ***significant at P<0.001.

Egg weight and egg surface area were increased significantly (P<0.001) with the decrease in albumin ratio (-0.604) and Haugh unit (-0.542). Concretely, the correlation of the egg width with albumin weight and yolk weight was positive with significant differences (P<0.001), moreover, it was increased (P<0.05) with the increase in yolk ratio, height and its width. Nerveless, egg width was negatively correlated with albumin ratio (-0.405) and Haugh unit (-0.432). While, the length of the egg was correlated positively with albumin weight and yolk width. On the other hand, the egg shape index was positively correlated with yolk weight and negatively correlated with albumin ratio. These results were disagreed with Ozcelik [35], who noted a negative correlation between the egg shape index and yolk weight. Otherwise, the increase in shell weight was correlated with the decrease in albumin ratio (-0.377) and Haugh unit (-0.512). The increase in shell ratio was followed by the decrease in yolk weight and its ratio. Kul and Seker [5] stated that albumen quality was correlated reversely with yolk and shell ratios.

Conclusion

In this study, housing Japanese quails at the different housing systems associated with significant differences in the most of egg quality and increased the most of the traits in cage system. Therefore, we can conclude that most of the egg quality (internal and external traits) were better in cage system and deep litter system with fine sawdust in comparison to the deep litter system with coarse sawdust.

Conflict of interest

The authors have no any conflict of interest.

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الملخــص العربــــى

تقييم جودة البيض ومدى الإرتباط بينهما فى السمان الياباني في أنظمة الإسكان المختلفة

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تم تقسيم ١٣٥ طائر من السمان الياباني في الأسبوع الخامس من العمر إلى ثلاث مجموعات، حيث كانت المجموعة الأولى قد أويت في أقفاص معدنية مجلفنة، في حين كانت المجموعتين الثانية والثالثة أويت في حظائر مغطاة بنشارة ناعمة وخشنة، على التوالي. كانت المساحة المتاحة للطائر الواحد ٠.٠٦ م^{٢} مع تطابق نظام التربية وتحت نفس الظروف المناخيية فى كل المجموعات. أظهرت النتائج ان طول البيض، مؤشر شكل البيض، وزن القشرة، نسبة القشرة وسمكها تأثرت بشكل كبير بنظام الاسكان. أظهرت النتائج ان طول البيضة (٢٩.٩٨ مللى) فى نظام الفرشة المغطاة بنشارة الخشب الناعمة كانت الاقل بالمقارنة لباقى المجموعات, فى حين كان مؤشر شكل البيض (٨٢.٧٥%)، وزن القشرة (١.٦٩ جرام)، نسبة القشرة (١٥.٨٨%) وسمك القشرة (٠.٢٧ مللى) الاعلى فى نظام الفرشة المغطاة بنشارة الخشب الناعمة مع وجود فروق معنوية. من ناحية أخرى كان وزن البيض (١١.٩٩ جرام), مساحة سطح البيض (٢٢.٩١ سم^{٢}) وعرض البيض (٢٥.٨٦ مللى) أعلى فى نظام الاقفاص مع عدم وجود فروق معنوية. وعلاوة على ذلك، تأثرت معظم سمات البيض الداخلية بشكل كبير من قبل أنظمة الإسكان المختلفة، في حين لم تكن هناك فروق ذات دلالة معنوية في نسبة الألبومين، وعرضه، ووزن صفار البيض ونسبته. كان هناك ارتباط إيجابي وسالب بين جودة البيض الداخلية والخارجية للسمان الياباني. لذلك، يمكننا أن نخلص إلى أن معظم سمات البيض سواء كانت الداخلية أو الخارجية كانت أفضل في نظام الاقفاص و الفرشة المغطاة بنشارة الخشب الناعمة بالمقارنة مع نظام الفرشة المغطاة بنشارة الخشب الخشنة.