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Effect of Housing System on Japanese Quail Performance

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ABSTRACT

This study was conducted to investigate the effect of two different housing systems; floor pens vs. battery cages on productive traits in Japanese quail. Three hundred, one day old chicks were individually weighed and randomly divided into two equal experimental groups according to housing system (150 birds in each group), each group was randomly assigned to three replicates. Body weight, body weight gain, feed consumption, feed conversion ratio and mortality rates were recorded weekly during the first experimental period. At the end of the growing period slaughter test was carried out to estimate carcass quality characteristics. Feed intake , feed conversion ratio and mortality rates were recorded. The dressed carcass, heart, liver, head and gizzard were weighed. The pooled weight of heart, liver, gizzard, and edible meat were designated as total edible meat (TEM). Using floor pens improved Gizzard weight, and gizzard percentage values compared to battery cages. Egg production, and egg quality traits, were estimated during the second experimental period. It was concluded that housing system had no significant effect on productive most traits of Japanese quails. Using floor pens improved gizzard weight, gizzard percentage, egg yolk weight and egg yolk percentage values of floor pen reared quails compared to battery cages. It was concluded that housing system had no significant effect on most of productive traits of Japanese quail

Keywords: Quails – housing system – rearing system – meat production – carcass characteristics - egg production – egg quality.

INTRODUCTION

The Japanese quail, Coturnix japonica is known to have been domesticated since the 12th century AD in Japan, mainly for its ability to sing. Species intensive production started in Japan in the 1920s. The first egg lines were then developed by selection. They were successfully introduced from Japan to America, Europe and Middle East between the 1930s and 1950s, where specific lines were bred for egg and meat production (Ashok and Prabakaran, 2012). Extensive research on Coturnix japonica has showed that it was a valuable animal for avian research (Jung *et al*., 2009).

Housing system is the most important factor affecting poultry production; therefore many researchers studied the effect of housing systems on behavioral, productive and reproductive traits of poultry (Roshdy *et al*., 2010).

The significant role of housing system (cage vs. deep litter) is well documented in chicken, whereas similar information is meager in the emerging area of Japanese quail production.

Quails are reared in multi-tiers cages both during growing and laying periods. However, quails are also being reared on floor equally well and system of housing did not affect the quail's egg production (Padmakumar *et al*., 2000). Housing system is the most important factor affecting poultry performance (Roshdy *et al*., 2010). Cage reared quail had higher egg production than that reared on littered floor (Alam *et al*., 2008). System of rearing of Japanese quail did not influence the fertility level significantly (Arumugam *et al*., 2014).

This study was conducted to investigate the effect of two different housing systems (floor pens vs. battery cages) on productive traits in Japanese quail under Egyptian conditions. Data collected concluded: body weight, feed intake, feed conversion during growing period, and carcass characteristics. Also, age on onset of sexual maturity, egg production and egg quality in Japanese quail during laying period.

MATERIALS AND METHODS

This study was conducted from January to May, 2017 in private farm at Qaliobya province, north of Egypt.

A total of 300 post-hatching chicks were randomly selected for the present study from the previous population. They were divided into two groups (150 chick per group) in three replicates (50 chick per replicate).

The chicks of the first group were raised on three battery cages in one commercial battery brooder as treatment A (battery cage). The battery was provided with wire floor over galvanized trays for dropping feces. Each battery compartment (L*W*H = 89*89*24 cm) contained two feed troughs and one water trough hanged separately outside the compartment. The second group of chicks were raised in three deep litter compartments as treatment B (floor pen). The pen compartment (L*W*H = 89*89*89 cm) was covered by 5 cm layer of wood shaving. Each compartment was provided with two feed troughs and converted cup drinker. All birds in treatment A and B were allowed for 24 hours of artificial light using one electric lamp (100 Watt). The battery cage and the littered pen rooms were electrically heated.

The experimental design :

Two experiments were conducted in the present study to compare quail productivity under two different housing systems.

Experiment I (Growing period) :

This experiment was carried out during the growing period. The experimental quail chicks were allotted randomly over the battery and litter pen compartments. They were fed ad lib on a grower diet satisfying NRC (1994) requirement for growing Japanese Quail. Dietary composition and calculated analysis are presented in Table 1. Performance parameters: Body weight , body weight gain, feed intake, feed conversion ratio and mortality were recorded weekly.

Carcass characteristics :

At the end of the growing period slaughter test was carried out to estimate carcass quality. Therefore, sixty representative male quail chicks, (thirty from each group) 6 weeks old were randomly selected, weighed and slaughtered by neck dislocation. Carcass were eviscerated by removing viscera, including crop, and esophagus and removing the head and neck. The dressed carcass, heart, liver , head and gizzard were separated and weighed on electrical balance to the nearest 0.1 gm. The pooled weight, heart, liver, head, gizzard, and edible meat were designated as total edible meat. It was calculated as a percentage of starves weight.

Experiment II (Laying period) :

This experiment was carried out during the laying period. At the end of the growing period a number of 120 adult female were randomly selected separated and placed in their corresponding battery or littered pen compartments. Sixty female bird of the first group were raised on three battery cages as treatment A. Sixty female bird of the second group were raised on deep littered compartment as treatment B (floor pen) . All birds in treatment A and B were allowed for 24 hours/day of artificial light using one electric lamp (100 Watt) . They were fed ad lib from 6 to 17 week of age on a quail layer diet covering NRC (1994) requirement for laying Japanese Quail. Nutritional value of diets is shown in Table 2. Dietary composition and calculated analysis are presented in Table 2. The laying hens performance parameters: Feed intake, feed conversion ratio to egg, egg number egg weight and mortality were recorded daily undertaken for comparison between the two housing systems.

Egg production :

Interior and exterior parameters of eggs quality were evaluated at 20 weeks of age,` within 24 h of collection. We analyzed thirty eggs at each evaluation time. Throughout the study, 60 birds were maintained in normal environmental conditions in each housing system. During the egg production period, Japanese quails were fed ad libitum commercial feed diet for laying hens and quails. El-Sheikh et. al.,(2016) reported that :

$$\text{HDP (\%)} = \frac{\text{Total egg number}}{\text{Daily hen number}} \times 100$$

$$\text{HHP (\%)} = \frac{\text{Total egg number}}{\text{Initial number of hen's} \times \text{Day's number of season}} \times 100$$

$$\text{SP (\%)} = \frac{\text{Total egg number}}{\text{Final number of hen's} \times \text{Day's number of season}} \times 100$$

$$\text{Laying rate (\%)} = \frac{\text{Egg number}}{\text{Hen number}} \times 100$$

HDP : Hen Day Production HHP : Hen Housed Production

Egg Quality :

At the 12th and 13th week of age a number of 30 eggs were selected randomly from each treatment. Egg weight , egg shell weight and thickness, albumin height using Tripod Micrometer to the nearest one-tenth of millimeter, albumen width using Vernier Calipers to the nearest one-tenth of centimeter and yolk height. They were used to compute the International Quality Unit (IQU) Kondaiah et. al. (1983). Shell thickness was computed from the average thickness of three random pieces, each at broad, middle and narrow position of the shell. The shell with the shell membrane of each egg was wiped out with tissue-paper to remove the residual albumen and weighed (Singh and Panda, 1987). The Haugh unit indicates egg quality as conceived by Dr. Raymond Haugh in 1937. The height of the thick albumen surrounding the yolk, combined with the egg weight, determines the Haugh unit score. The higher the score, the better the egg quality. The yolk and albumen height and width (mm) were measured using an electronic caliper (Reddy *et al*., 1979). The following undertaken measurements of internal egg quality traits were calculated according to Romanoff and Romanoff (1949) :

1. Fresh egg weight
2. Yolk weight and Yolk percentage

$$\text{Yolk index \% as} = \frac{\text{Yolk height (mm)}}{\text{Yolk diameter (mm)}} \times 100$$ **(Mirjana *et. al* 2012)**

3. Yolk color (using the color chart method)
4. Albumen weight (gm)and Albumen percentage
5. Albumen height
6. **Albumen index as** $= \frac{\text{short diameter}}{\text{long diameter}}$
7. Shell weight (gm) and shell percentage
8. Shell thickness (inch)
9. **Internal Quality Unit (IQU) as** $= 100 \log (H + 4.18 - 0.98989\, W^{0.6674})$

where : H is the observed albumen height (mm) and W is egg weight (gm)

Yolk Index :

The yolk index is calculated by dividing the yolk height by the yolk diameter of the egg broken onto a flat surface. It was used as an egg quality indicator in the 1930s. As egg deterioration progresses, the yolk index score becomes lower because the fiber structure of the vitelline membrane loosens and the membrane strength decreases over time. The yolk index score is calculated by the following formula: the height of the egg yolk broken onto a flat surface combined with the diameter.

$$YI = YH/YD$$

YI: Yolk index, YH: Height of egg yolk , YD: Diameter of egg yolk

Statistical Analysis:

Data were analyzed using the General Linear Model (GLM) procedure of SAS (SAS Institute Inc., 1998). Least Square Means (LSM) were calculated and Least Square Differences (LSD) between means was tested. The mathematical models used for body weight and egg quality were: $Y_{ij} = \mu + H_i + e_{ij}$

Where:

- Y_{ij} = the observation on the j^{th} individual from the i^{th} housing system.
- μ = the overall mean.
- H_i = the fixed effect of the i^{th} housing systems (i= floor pens and cages).
- e_{ij} = the random error associated with the ij^{th} individual.

Table 1. Percentage composition and calculated analysis of the grower quail diet:

Ingredients	%
Corn Yellow (8.8%)	61.9
Fish Meal (72%)	6.0
Corn Gluten (48.5%)	4.0
Soy Bean Meal	25.0
Bone Meal	2.5
Na Cl	0.3
Vitamins and Minerals Mixture	0.3
Total	100

CP : Crud Protein = 24 % **ME : Metabolizable Energy = 3000 K.cal**
Ly : Lysine = 1.15 **Met : Methionine = 0.8**
Ca : Calcium = 2.6 % **Ph :Phosphorus = 0.58 %**

Each Kg of the vitamins and minerals Mixture contained :

Vitamin A	50000 IU	Vitamin D	10000IU
Vitamin E	48 IU	" K	4gm
Vitamin B2	14.4 mg	Pantothenic Acid	44 mg

Niacin	280	mg	Vitamin B12	0.012	
mgBiotin	0.8	mg	Folacin	4.0mg	
Thiamine	8.0	mg	Pyridoxine	18.0 mg	
Magnesium	2400	mg	Manganese	240 mg	
Zinc	300	mg	Iron	320	mg
Copper	32	mg	Iodine	1.6	mg
Selenium	0.8	mg			

RESULTS AND DISCUSSION

The objective of this work was to evaluate the effect of housing system on quail growth performance and carcass characteristics .

Experiment I

Effect of housing system on growth performances:

Body weight:

Data in Table 2 showed that initial body weight was equal 6.5 gm for battery cage and floor pen reared quails. There were no significant differences between battery cage and floor pen reared quails in average weekly body weight WBW. At the end of the experimental period, birds stocked at battery cages recorded insignificant ($P \leq 0.05$) higher final body weight (FBW). These data are in agreement with Roshdy et. al. (2010) and Abd El-Gawad *et. al.* 2008. But, Razee *et. al.* (2016) found that rearing system had significant influence on body weight of growing Japanese quails.

Table 2. Effect of different housing system on body weight:

Week	Battery cages		Floor pen	
	BW	± SE	(BW)	± SE
0-1	21.13	± 0.03	23.03	± 0.03
1-2	57.20	± 1.28	59.06	± 1.00
2-3	88.83	± 1.04	92.53	± 1.03
3-4	140.76	± 1.65	150.40	± 1.79
4-5	195.80	± 1.71	196.50	± 1.80
5-6	236.63	± 1.82	240.46	± 1.93

Body weight gain:

Data presented in Table 3 showed there were no significant differences between battery cage and floor pen reared quails in weekly body weight gain and total body weight gain. Our results are higher than those recorded by Abd El-Gawad *et. al.* 2008. Our findings were in disagreement with Razee *et. al.* (2016) who found that body weight gain were significantly ($P<0.01$) higher in cage birds compared to the littered floor birds. Also, they reported that cage birds gained weight faster and reached higher body weight than birds on littered floor. On the other hand the present results are in agreement with the observation of Ojedapo and Amao (2014) who reported that floor housed quail birds had significantly heavier weight gain that cage housed quails.

Table 3 . Effect of different housing system on body weight gain:

Week	Battery cages		Floor pen	
	(BWG)	± SE	(BWG)	± SE
0-1	14.63	± 0.05	16.53	± 0.03
1-2	36.07	± 1.26	36.03	± 1.03
2-3	31.63	± 2.97	33.47	± 0.96
3-4	51.93	± 2.39	57.87	± 0.52
4-5	55.04	± 0.84	46.10	± 1.07
5-6	40.83	± 0.72	43.96	± 3.06
Total	230.13	± 2.20	233.96	± 2.62

Feed intake:

Table 4 showed that there were no significant differences between battery cage and floor pen reared quails in weekly feed intake (WFI) and total feed intake (TFI) during the first experimental period. The recorded results for total feed intake TFI during whole experimental period as shown in table 4 were similar to those of Abd El-Gawad *et. al.* 2008 who found that total feed intake was 797.00 gm. Razee *et. al.* (2016) found that rearing system had significant influence on feed intake of growing Japanese quails.

Table 4 . Effect of different housing system on feed Intake:

Week	Battery cages		Floor pen	
	(FI)	± SE	(FI)	± SE
0-1	32.6	± 0.15	33.89	± 0.08
1-2	59.16	± 2.32	57.65	± 2.96
2-3	93.38	± 2.27	93.63	± 1.94
3-4	139.94	± 4.99	143.61	± 8.03
4-5	187.32	± 1.36	186.71	± 5.75
5-6	183.74	± 1.32	186.50	± 7.84
Total	696.14	± 2.74	701.99	± 2.88

Feed conversion ratio:

There were insignificant ($P \leq 0.05$) differences between quails kept in battery cages and floor pen in weekly feed conversion ratio (WFCR) and total feed conversion ratio (TFCR) during the first experimental period, as shown in Table 6. The insignificant improvement of feed conversion ratio in floor pen than in cages could be attributed to consumption of floor litter materials. These ratio are better than those recorded by Abd El-Gawad *et. al.* 2008 who found that total feed conversion ratio was 4.04. However, the present results were in disagreement with Abdel - Magied (2006), who reported that the feed efficiency for Japanese quail housed in battery cage was higher than birds housed on the litter floor. Also, these results were in disagreement with Padmakumar *et al*. (2000) who revealed that the average feed efficiency for Japanese quails in battery cage and deep litter floor from 5 to 50 weeks of age was not affected with housing system. Razee *et. al.* (2016) found that rearing system had significant influence on feed conversion ratio of growing Japanese quails.

Mortality:

Data of mortality number and percentage during the whole experimental period represented in Table 6 showed that there were insignificant ($P \leq 0.05$) differences between quails kept in battery cages and floor pen. This result is in disagreement with Razee *et. al.* (2016) who found that rearing system had significant influence on mortality rate.

Table 5 . Effect of different housing system on Feed Conversion Ratio (FCR):

Week	Battery cages		Floor pen	
	(FCR)	± SE	(FCR)	± SE
0-1	2.23	± 0.0	2.05	± 0.0
1-2	1.64	± 0.04	1.60	± 0.12
2-3	2.95	± 0.39	2.80	± 0.17
3-4	2.70	± 0.39	2.48	± 0.30
4-5	4.40	± 0.22	4.05	± 0.05
5-6	4.50	± 0.46	4.24	± 0.80
Total	3.03	± 0.01	3.00	± 0.01

Effect of housing system on carcass characteristics:

Live body weight:

The birds randomly taken to slaughter from battery cages recorded live body weight 239.33 gm compared with the birds from floor pen 244.33 gm. Data presented in Table 8 showed that there were no significant differences between the two groups of quails in live body weight. Razee *et. al.* (2016) found that the differences in live weight. Live weight was highest in floor pen housed birds. Walita *et. al.* (2017) found that slaughter weight was 130.6 gm for 35 day old quails reared under intensive management system in cages.

Edible viscera:

Data presented in Table 7 showed that edible viscera weight for floor pen reared quails were significantly higher than battery cage reared quails. The recorded results for edible viscera weight were 16.89 and 19.86 gm for battery cages and floor pen, respectively. Also, edible viscera percentage was significantly higher in floor pen reared quails than battery cages reared quails. Data represented in table 8 for edible viscera percentage were 7.05 and 8.13 % for battery cage quails and floor pen quails respectively. Our findings for edible viscera weight and edible viscera percentage were significantly higher in floor pen reared quails than battery cages reared quails due to higher gizzard weight and percentage. We suggest that floor pen reared quails consumed hay from the floor, which was not available in the battery cages. This finding is in agreement with Razee *et. al.* (2016) who found that there significant differences in gizzard weight ($P<0.05$). Also they found that there was no difference in the weight of liver, weight, between cages housed and littered floor house quails. They found that liver weight had non significant effect on two rearing system. Walita *et. al.* (2017) found that liver, gizzard and heart % were 4.82, 0.897, 2.08 and 2.86 %, respectively.

Dressed yield:

Data presented in Table 7 showed that dressed yield weight for battery cage reared quails and floor pen reared quails were (179.09 and 182.04) gm, respectively. There were no significant effect for rearing system (battery cage vs. floor pen) on dressed yield weight.

Data presented in Table 7 showed that dressed yield percentage for battery cage reared quails and floor pen reared quails were (74.83 and 74.67) %, respectively. Housing system has no significant effect on dressed yield percentage. Walita *et. al.* (2017) found that dress percentage was 70.8 % for quails reared in cages .

Yield with edible viscera: Data presented in table 7 showed that yield with edible viscera weight for battery cage reared quails and floor pen reared quails were 195.98 and 201.9 gm respectively. Statistical analysis showed that housing system has no significant effect on yield with edible viscera weight. This data is in agreement with Paulo *et. al.* (2017) who reported that yield with edible viscera weight was (201.08) gm for control quails group at 35 days of age .

Data presented in Table 7 showed that yield with edible viscera percentage for battery cage reared quails and floor pen reared quails were 81.88 and 82.63 % respectively. Statistical analysis showed that housing system has no significant effect on yield with edible viscera percentage. Paulo *et. al.* (2017) found that yield with edible viscera percentage was (78.71 %) for control quails group at 35 days of age .

Table 6. Effect of different housing system on mortality:

	Battery cages		Floor pen	
	Mortality	± SE	Mortality	± SE
Mortality No.	5		5	
Mortality %	3.33	± 0.0	3.33	± 0.0

Table 7 . Carcass Characteristics for quail reared under different housing system (battery cages and floor pen):

Carcass Characteristics (CC)		Battery cages (CC)	Floor pen (CC)
Live Body Weight		239.33	244.33
Edible Viscera	Weight (gm)	16.89[b]	19.86[a]
	%	7.05[b]	8.13[a]
Liver	Weight (gm)	6.34	6.74
	%	2.65%	2.76%
Gizzard	Weight (gm)	6.41[b]	8.94[a]
	%	2.68%[b]	3.66%[a]
Heart	Weight (gm)	4.14	4.18
	%	1.73%	1.71%
Dressed Yield	Weight (gm)	179.09	182.04
	%	74.83	74.67
Yield with Edible Viscera	Weight (gm)	195.98	201.9
	%	81.88	82.63

[a, b] **The means within the same row with different letter, have significant difference ($P\leq0.05$)**

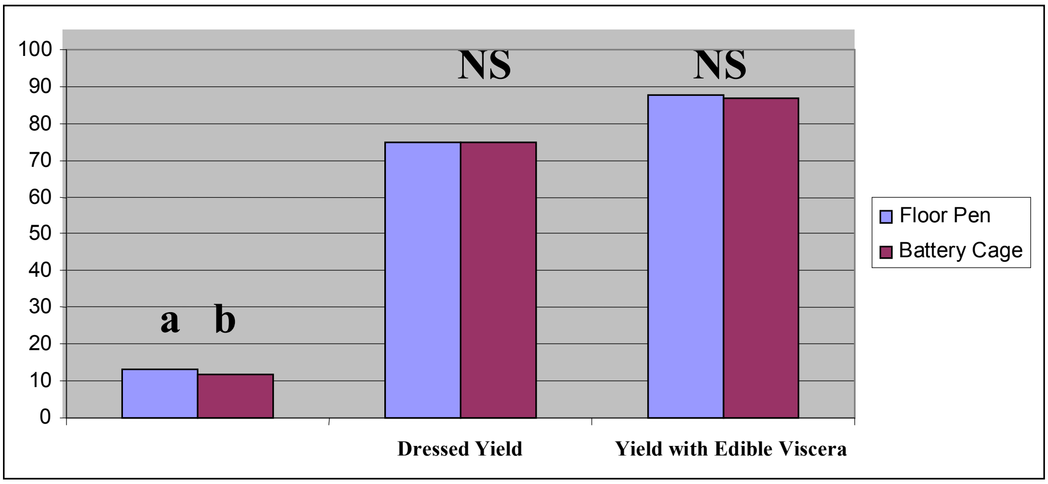

Figure 1. Carcass percentage for quail reared under different housing system (battery cages and floor pen)

Experiment II

Effect of housing system on Egg production traits:

Data in Table 8 showed the effect of different housing systems from 12 to 17 weeks of age , there were no significant differences in egg production (No.), egg production (%) / day, egg production (%) / Hen/day, total egg weight (gm.), total feed intake egg and weight mean.

Table 8. Effect of different housing system on body Weight :

Egg Production (EP)	Battery cages		Floor pen	
	(EP)	± SE	(EP)	± SE
Body Weight (at12th week) gm	223.50	± 1.24	235.34	± 1.25
Body Weight (at17th week) gm	235.10	± 1.22	248.79	± 1.24

Body weight at 12th and 17th week:

Data represented in Table 8 showed that females raised on litter floor had insignificantly higher body weight at 12th week of age than battery cage reared females. Also, females raised on deep litter floor pen had insignificantly higher ($p \leq 0.05$) body weight at 17th week of age (248.79 gm) than those kept in battery cages (235.10 gm). These data is in agreement with El-Sheikh *et al*., (2016) who reported that the females raised on litter floor had significantly higher ($p \leq 0.05$) body weight than those kept in battery cages. This improves in body weight for Japanese quails raised on litter floor could be attributed to improve in viability, physiological body status as well as rearing condition than those of quails reared in battery cages.

Egg Production (Number and weight):

Data collected during 9 days within 12th - 17th week of age period presented in Table 8. Data showed that the housing system had no significant effects on egg weight, egg number and egg production. These results are in agreement with those of El-Sheikh *et al.*, (2016) who found that housing system did not affect the egg production in Japanese quail at 5-50 weeks of age. Hen day egg production was not significantly ($P \leq 0.05$) affected with rearing system. These results are in agreement with those of El-Sheikh et. al., (2016). There were no significant differences in percent hen day egg production between battery cage and floor pen deep litter reared quails. These results are in agreement with those of El-Sheikh *et al.*, (2016). The different housing system did not affect the average total egg weight of Japanese quail. This in average, same to that reported by Santos *et al*. (2011. There were no significant effects for housing system on egg weight mean. This finding is in agreement with those of El-Sheikh *et al*., (2016) .

Table 9 . Effect of different housing system on egg and Feed Conversion Ratio:

Egg Production (EP)	Battery cages		Floor pen	
	(EP)	± SE	(EP)	± SE
Quail No.	60	± 0.0	60	± 0.0
Egg Production (No.)	486	± 1.43	490	± 1.66
Egg Production /Hen	8.01	± 0.10	8.17	± 0.11
Egg Production (%) Hen/day	80.1	± 0.58	81.7	± 0.61
Total Egg Weight (gm./10 days/60 hen)	7600^b	± 3.23	7700^a	± 3.41
Egg Weight Mean	12.67	± 0.60	12.83	± 0.53
Total Feed Intake	25384	± 2.56	25333	± 2.71
Feed Intake Mean (gm feed/bird/day)	42.31	± 1.02	42.22	± 1.02
Feed Conversion Ratio (gm feed/gm egg)	3.34	± 0.03	3.29	± 0.03

Feed intake and feed efficiency :

The results in Table 9 indicated that birds raised on litter floor had insignificantly higher ($p \leq 0.05$) feed intake than those in cages. These results are in agreement with Olawumi Simeon , 2015). Also, there were no significant ($p \leq 0.05$) effect for housing system on feed conversion ratio during production period . Feed efficiency (gm feed per gm eggs) did not differ significantly ($P > 0.05$) between cage and deep litter reared quails. These results are in agreement with Padmakumar *et al*. (2000) who revealed that the average feed efficiency for Japanese quails in battery cage and deep litter floor from 5 to 50 weeks of age was not affected with housing system.

Effect of housing system on egg Quality (EQ) traits :

Data presented in Table 10 showed the effect of different housing systems on egg quality traits : egg weight , yolk index , yolk color , yolk weight , yolk % ; albumen index, albumen weight , albumen % ; shell thickness (inch) , shell weight , shell % ; egg shape and international quality unit (IQU). Data obtained in table (5) showed that there were no significant differences in egg production (No.), egg production (%) / day, egg production (%) / Hen/day, total egg weight (gm.), total feed intake egg and weight mean.

Egg Weight: Data presented in Table 10 showed that there were no significant effect for two housing systems on egg weight (gm) of Japanese quail . Our results regarding egg weight in the two different housing systems were comparable to (Jatoi *et al*. 2013) . The observed difference between our findings and that of others may be attributed to several mechanisms including increased feed intake .

Yolk Index, Color and weight: Data presented in table 10 showed that different housing system did not affect yolk index. Our results regarding yolk index were in agreement with the data reported by (Erensaymn and Camci, 2002). Yolk color was not affected by the housing system. In the present experiment, the yolk color were 6.61 and 6.54 for battery cage and floor pen reared quails ,respectively. Quail eggs have higher proportions of yolk than those from hens (Zita *et al*., 2013). There were a significant increase in yolk weight and yolk percent of floor pen than battery cage reared quails, respectively. These results are in agreement with Ewa *et al.* 2007 who reported that yolk weight was 4.3 gm in Japanese quails (Coturnix japonica) during laying cycle.

Table 10 . Effect of different housing system on Egg Quality (EQ) :

Egg Quality (EQ)		Battery cages		Floor pen	
		(EQ)	± SE	(EQ)	± SE
Egg Weight		12.60	± 0.16	12.76	± 0.22
Yolk	Index	56.45	± 0.01	56.67	± 0.01
	Color Index	6.61	± 0.17	6.54	± 0.21
	Weight	4.03[b]	± 0.08	5.11[a]	± 0.09
	%	31.98[b]	± 0. 6	40.05[a]	± 0. 6
Albumen	Index	12.67	± 0.01	13.18	± 0.01
	Weight	7.49[a]	± 0.11	6.55[b]	± 0.14
	%	59.45 [a]	± 1.19	51.33 [b]	± 1.24
Shell	Thickness(mm)	0.225	± 0.01	0.225	± 0.01
	Weight	1.08	± 0.02	1.10	± 0.02
	%	8.57	± 0.12	8.62	± 0. 14
Egg Shape		81	± 0.007	79	± 0.011
International Quality Unit		86.09	± 0.14	86.62	± 0.12

[a , b] The means within the same row with different letter, have significant difference (P≤0.05)
International Quality Unit = 100 log (H+4.18 - 0.8989 $W^{0.6674}$)

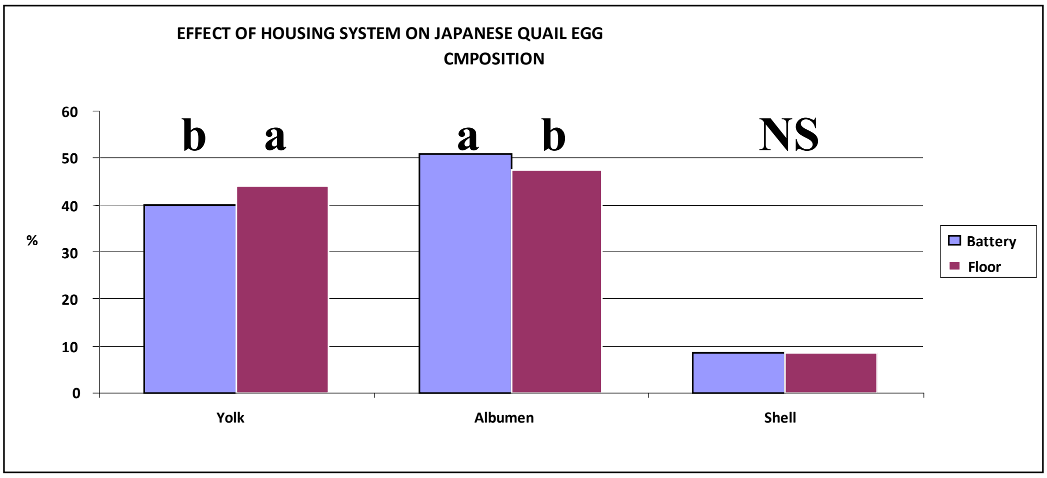

Figure 2. Internal Egg Quality (EQ) for quail reared under different housing system (battery cages and floor pen)

Albumen Index and Weight : Table 10 represented that different housing system did not affect albumin index for battery cages and floor pen reared quails, and these data are in agreement with Jessy Bagh et. al. (2016). The albumen index for laying Japanese quail was in accordance with albumen height similarity. Albumen height affect the viscosity levels, which can directly affect the shelf life of eggs . Consumers judge the quality of eggs by albumen viscosity making this an important quality trait.

Our results shown in Table 10 revealed that there were significant increase in albumin weight and albumin percent in battery cage than floor pen reared quail. These results are in agreement with (Sari *et al.* 2012) and Mirjana *et al.* (2012).

Shell Thickness, weight and percentage: The most important quality traits of the egg shell are its thickness. In our study, there were no significant differences between the two housing systems battery cages and floor pen in quail egg shell thickness and shell weight. The egg shell thickness and shell percentage values in this experiment were similar to Hemid et. al. 2010. The results of shell weight were similar to those reported by (Zita *et al.* 2013). The relatively increase in shell weight of floor pen reared quails may be due to an increase in the egg weight , because the heavier eggs stayed longer in the reproductive tract mainly in the uterus for calcification and pigmentation.

Egg Shape : The data represented in Table 10 showed that there were insignificant differences in egg shape between battery cage and floor pen reared quails (81 and 79), respectively. Our results of egg shape index in the Control line were compatible with the findings of others (Pérezdela Mora *et al.* 2014).

International Quality Unit (Haugh unit) : There was no significant (P>0.05) difference determined between the housing systems for the Haugh Unit. The Haugh Unit values in this study was in agreement with (Oliveira *et al.* 2007) and (Nickolova and Penkov 2010). The higher the Haugh unit, the more desirable is the interior quality of the egg .Data in Table 10, shows that there was insignificantly effect of housing system (battery cage vs. floor pen) on egg weight, yolk color, yolk index, albumin index, shell weight, shell percentage, shell thickness, egg shape, and Haugh unit. However, eggs laid on litter floor had higher (p≤0.05) yolk weight , yolk percentage, than those laid in battery cages. Consequently, eggs laid in battery cages had a higher (p≤0.05) albumin weight , albumin percentage, than those laid in litter floor. These findings helps to judge that there is no adverse effect of the housing system on growing and laying performance of Japanese quail .

CONCLUSION

Generally, from these results it could be concluded that raising Japanese quails either in battery cages or floor pens had no significant effects on most egg production , and egg quality traits.

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تأثير نظام الإسكان على أداء السمان الياباني

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أجريت هذه الدراسة لتقييم أداء إنتاج السمان الياباني الذي يتم تربيته في البطاريات أوعلى الأرض , من أجل اقتراح نظام مناسب لتربية السمان الياباني لخفض تكلفة السكن وتحقيق كفاءة أفضل . وقد أجريت هذه الدراسة في مزرعة سمان خاصة , وقد إشتملت على تجربتين : التجربة الأولى :حيث تم تقسيم 300 طائر سمان عمر يوم إلى مجموعتين , في كلِ 150 طائر , و كل مجموعة قسمت إلى ثلاثة مكررات , في كل مكررة 50 طائر . المجموعة الأولى تم تربيتها من عمر يوم حتى نهاية الأسبوع السادس من العمر في بطاريات من ثلاثة أدوار , كل دور ذات أرضيات من السلك المجلفن أبعادها (طول*عرض* إرتفاع = 89 * 89 * 24 سم) وتم تربية 50 طائر في كل دور . والمجموعة الثانية تم تربيتها في ثلاثة أعشاش أرضية مفروشة بنشارة الخشب الناعم بإرتفاع 5 سم , وكانت أبعاد العش الأرضي (طول*عرض* إرتفاع = 89 * 89 * 24 سم). التجربة الثانية : حيث إستخدم عدد 120 أنثى من عمر 12-18 أسبوع وقسمت إلى مجموعتين : المجموعة الأولى: تم تربية 60 أنثى وزعت على ثلاثة أدوار من بطارية ذات أرضيات من السلك المجلفن أبعادها (طول*عرض* إرتفاع = 89 * 89 * 24 سم). المجموعة الثانية: تم تربية 60 أنثى وزعت على ثلاثة أعشاش أرضية مفروشة بنشارة الخشب الناعم بإرتفاع 5 سم , وكانت أبعاد العش الأرضي (طول*عرض* إرتفاع = 89 * 89 * 24 سم). القياسات : الأداء الإنتاجي للسمان : وزن الجسم الأسبوعي , إستهلاك العلف الأسبوعي , معامل التحويل الأسبوعي , الوزن النهائي . صفات الذبيحة : في نهاية الأسبوع السادس تم ذبح 30 طائر من الذكور من كل معاملة عشوائيا , وتم أخذ القياسات على الذبيحة : الوزن الحي , الوزن الصافي , وزن الأجزاء المأكولة (الذبيحة , القونصة , القلب , الكبد) . وقد كانت النتائج كما يلي : إنتاج البيض: الإنتاج اليومي للبيض (وزن و عدد ونسبة مئوية , وزن البيض في الأسبوعين 16 و 17 , إنتاج البيض (عدد) , وزن الجسم في الأسبوع 12 و 17 (جم) , وزن الصفار (جم) , لون الصفار وتم حساب دليل الصفار (إرتفاع الصفار \ القطر) ونسبته المئوية من وزن البيضة (جم) , وزن البياض (جم) و تم حساب دليل البياض (القطر القصير \ القطر الطويل) ونسبته المئوية من وزن البيضة , سمك القشرة (بوصة) , وزن القشرة (جم) ونسبتها المئوية من وزن البيضة , وتم تقدير الجودة الداخلية للبيض . النتائج: الأداء الإنتاجي للسمان : لم يكن هناك أي إختلافات معنوية بين السمان المربى في بطاريات ذات أرضيات سلك مجلفن وبين السمان المربى على الأرض على فرشة من نشارة الخشب في متوسط وزن الجسم الأسبوعي , متوسط إستهلاك العلف الأسبوعي , و متوسط الزيادة الأسبوعية في الوزن , و متوسط معامل التحويل الأسبوعي . صفات الذبيحة : وبعد أخذ مواصفات الذبيحة وجد أن الإختلافات بين السمان المربى في بطاريات و السمان المربى على الأرض لم تكون إختلافات معنوية في : الوزن الحي , الوزن الصافي , وزن الأجزاء المأكولة (الذبيحة , القونصة , القلب , الكبد) , و قد وجد هناك إختلافات معنوية عند مستوى معنوية 0.05 في متوسط وزن القونصة ونسبتها المئوية الذي كان أعلى في السمان المربى على الأرض من السمان المربى في بطاريات . إنتاج البيض: لم يكون هناك إختلافات معنوية بين الإناث المرباة في بطاريات أو على الأرض في الإنتاج اليومي للبيض (وزن و عدد ونسبة مئوية , وزن البيض في الأسبوعين 16 و 17 , إنتاج البيض (عدد) , وزن الجسم في الأسبوع 12 و 17 (جم) , لون ودليل الصفار, دليل البياض , سمك و وزن القشرة ونسبتها المئوية , و وحدات هوه للجودة الداخلية للبيض . بينما كان هناك إختلافات معنوية بين الإناث المرباة في بطاريات أو على الأرض وزن الصفار ونسبته المئوية , وزن البياض ونسبته المئوية , فقد كانت النتائج تشير إلى إرتفاع وزن و نسبة الصفار في بيض السمان المربى على الأرض وإنخفاض معنوي في وزن ونسبة البياض عن السمان المربى في بطاريات . توصية : يمكن التربية على الأرض أو في بطاريات دون حدوث أي إختلافات جوهرية في معظم الصفات الإنتاجية و صفات الذبيحة , و دون تأثر معدل الإنتاج ووزن البيض وسمك القشرة .