Egypt. Poult. Sci. Vol (30) (I): (55-67)

PRODUCTIVE AND REPRODUCTIVE TRATIS OF JAPANESE QUAIL AS AFFECTED BY TWO HOUSING SYSTEM

By

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Received**: 03/01/2010** Accepted: **02/02/2010**

Abstract: *This study was conducted to investigate the effect of two different housing systems; floor pens vs battery cages on productive and reproductive traits in Japanese quail. One hundred and eighty birds at 6 weeks of age were individually weighted and randomly divided into two equal experimental groups according to housing system (90 birds in each group, 30 male and 60 female), each group was randomly assigned to three replicates. Body weight, egg production and mortality rates were recorded. Fertility, hatchability and embryonic mortality percentages were calculated. Egg quality traits, plumage conditions and cloacal gland area were estimated during the experimental period. The results revealed highly significant differences (P<0.01) between floor pens and battery cages on most of the studied traits. Using floor pens improved laying rate, egg number, egg weight, egg mass, hatchability, yolk index, shell thickness, internal quality unit values compared to battery cages. In contrast, using battery cages increased body weight, plumage deterioration, male cloacal gland area and total mortality rate compared with floor pens during experimental period.*

It was concluded that floor pens housing system had significant positive effects on productive and reproductive traits of laying Japanese quail as compared with battery cages.

INTRODUCTION

Japanese quail have the advantage of rapid growth rate, small size, good reproductive potential, short life cycle, low feed requirements, good meat taste, better laying ability and shorter time of hatching as compared with the different species of poultry (Padgett and Ivey, 1959; Wilson *et al*., 1961; Reese and Reese, 1962; Cooper, 1976; Mady, 1976 & 1981). Many workers studied the effect of housing systems on performance of different poultry species. Several studies were done during the last several years to study the effect of housing system on behavioural, productive and

reproductive traits of poultry. Most of the studies reported that, housing system is the most important factor affecting poultry performance. So, keeping of laying hens in cages has been criticized around the world. However, in developed countries about 90% of hens are kept in cages (Tauson, 1998). Quail hens preferred to lay their eggs in nests. The percentage of eggs found in nests was significantly higher than those on floor that was covered with plants and artificial shelters (Schmid and Wechsler 1997). Laying hens kept in cages were significantly ($P< 0.05$) heavier than hens kept in barn provided with litter and free range systems (Van Loon *et al.*, 2004).

The objective of this work was to study the effect of two housing systems (floor pens *vs* battery cages) on productive and reproductive performance traits of laying Japanese quail.

MATERIALS AND METHODS

Birds and husbandry

This experiment was carried out during the period between November, 2006 to February, 2007 at the Poultry Farm, Department of Animal Production, Faculty of Agriculture, Suez Canal University, Ismailia, Egypt. Quails used in this experiment were kept under normal brooding conditions in brooding floor pens until they were six weeks of age under continuous light and with a gradual decrease in room temperature from 37°C at hatching to 25°C at 6 weeks of age.

At six weeks of age, 180 birds were individually weighted and randomly divided into two equal experimental groups according to housing system: the 1st group was kept on floor pens (100x80x60 cm) and the 2nd was kept in battery cages (100x80x35 cm). Each group was randomly assigned to 3 replicates (10 males and 20 females each). All birds were kept under similar conditions during the experimental period. The birds were subjected to 16hr light 8hr dark/day. Wood shavings were used as a litter on floor pens. Both feed contain 20.15 % protein and 3089.5 Kcal/kg and water were provided ad libitum to all experimental groups.

Studied traits Body weight:

The birds were individually weighted at the start of experiment (6 wks) and at 8, 10, 14 and 18 weeks of age.

Egg production parameters:

The daily egg production rates were recorded up from laying to 18 weeks age. Egg number, egg weight (g) and egg mass (g) were recorded.

Fertility, hatchability and embryonic mortality:

A total of 2250 eggs were used to determine fertility, hatchability and embryonic mortality (1300 eggs from floor pen group and 950 from battery cage group) at 10, 12, 14, 16 and 18 weeks of age. The eggs were collected daily and stored at room temperature for up to 5 days before they were placed in the incubator.

At hatching all live and dead chicks were counted. The unhatched eggs were opened and classified either as being infertile or embryonic dead. The embryonic mortality was classified into four groups, the 1^{st} group was early dead embryos (EDE) from 1-5 days, the 2^{nd} group was late dead embryos (LDE) from 6-15 days, the 3^{rd} group was dead in shell (DIS) from 16-17 days of incubation period, and the last group was pipped dead embryos (PDE) (Yakimenko *et al.,* 2002; Khalil, 2009).

Egg quality traits:

A total of 200 quail eggs were used to measure egg quality traits for two consecutive days (120 eggs from floor pens and 80 eggs from battery cages) at 14 and 18 weeks. Eggs from each treatment were collected, weighed and broken out. Egg shape index, internal quality unit, yolk shape index and shell thickness were calculated.

Plumage conditions:

Plumage scores were measured at 8, 10, 14 and 18 weeks of age. Three areas of the body were measured (head, neck and back) using a scale from 1(completely feathered) to 5 (featherless). The sum of the values for all three areas was calculated for each bird, with values ranging from 3(completely feathered) to 15 (featherless) according to Gerken (1991).

Cloacal gland:

The area of cloacal gland (mm^2) of males was measured using calipers at 8, 10, 14 and 18 weeks of age.

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 were:

$$\mathbf{Y_{ijk} = \mu + H_i + S_j + e_{ijk}}$$

Where:

Y_{ijk} = the observation on the k^{th} individual from the i^{th} housing system in j^{th} sex.

μ = the overall mean.

H_i = the fixed effect of the i^{th} housing systems (i= floor pens and cages).

S_j = the fixed effect of the j^{th} sex (j= males and females).

e_{ijk} = the random error associated with the ijk^{th} individual.

The mathematical models used for egg production, egg quality, fertility, hatchability and cloacal gland were:

$$\mathbf{Y_{ik} = \mu + H_i + e_{ik}}$$

Where:

Y_{ik} = the observation on the k^{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_{ik} = the random error associated with the ik^{th} individual.

RESULTS AND DISCUSSION

1- Body weight:

Average of live body weights of male and female quails as affected by different housing systems are given in Table (1). Results indicate that initial body weight (6 weeks old) did not differ significantly among the housing systems, indicating the complete randomization of distribution of birds into the experimental groups. However, after 6 weeks of age, males kept in battery cages had significantly heavier values than those kept on floor pens from 8 to 18 weeks of age. Also, females kept in battery cages had significantly heavier body weight than females kept on floor pens at 8 and 10 weeks of age. Akram *et al.*, (2000) found that Japanese quail chicks housed under floor system gained 27.06 % more weight than those reared under cage system. The average weight gain in males under floor system was 57.2 % more than males reared under cage system but the difference in females was minor 7.04 % more gain under floor system of housing. Apparently, the response of quails with respect to weight gain was better on the litter floor relative to the cage housing system as also reported by Heil, (1985); Pavlovski *et al.*, (1992). The response of

quails with respect to weight gain was better on the litter floor relative to the cage housing system (Pavlovski *et al.*, 1992). Also, Singh *et al.,* (2009) showed that Lohmann White hens on floor pens had greater body weight compared with hens in cages. White Leghorn hens housed in furnished cages were significantly ($P<0.05$) heavier than hens housed in battery cages (Pohle and Cheng, 2009).

2- Egg production traits:

Data in Table (2) showed the effects of different housing systems on laying intensity, egg number, weight and mass from 6 to 18 weeks of age. Quails kept on floor pens had significantly higher values in laying rate, egg number, egg weight and egg mass than those kept in battery cages. These results agree with those obtained by Pavlovski *et al.,* (1992) who found that egg production was higher when layers were housed in deep litter and free-range system than in cages. Also, Pistekova *et al.,* (2006) reported that the egg weight was significantly ($P<0.05$) higher in the deep litter system of laying hen keeping than cages. The highest percentage of broken eggs was observed in furnished cages (Guesdon and Faure, 2004). In relation to egg weight, Hidalgo *et al.,* (2008) reported that the eggs produced on floor had higher egg weight than produced in cage of laying hens. Also, Ozbey and Esen (2007) found that egg weight values were significantly ($P<0.05$) higher on floor than in cages system of Rock Partridges. Singh *et al.,* (2009) showed that Lohmann White hens on floor pens had greater egg weight compared with those produced on cages.

3- Fertility, hatchability and embryonic mortality:

Fertility, hatchability and embryonic mortality percentages of quail eggs from 6 to 18 weeks of age as affected by different housing systems are presented in Table (3). Analysis of variance of data showed non significant difference between two housing systems in fertility, hatchability and embryonic mortality rates except in early dead embryo (EDE). Maximum percentages of hatchability were obtained in eggs laid from quail housed in floor pens compared with the other eggs laid from battery cages. In contrast, total dead embryos were lower in eggs laid from quail housed in floor pens compared with the other eggs laid from battery cages. All stages of embryonic mortality (early dead embryo (EDE) %, late dead embryo (LDE) %, pipped (PIP) %) were lower in eggs laid from quail housed in floor pens compared with the other eggs laid from battery cages, except dead in shell (DIS) % was significantly higher.

This result indicated that, housing system affected reproductive performance of Japanese quail. Birds housed on cages had lower values than those housed on floor. Decreasing of hatchability and increasing on mortality rate might be returned to 3 reasons: The 1st reason may be attributed to non-specific stress. This stress causes hormonal imbalances, such as inhibition of GnRH secretion from the hypothalamus area which inhibit FSH and LH secretion from the anterior of pituitary gland, these hormones are playing an important role in the development of gonads in males and females (Catherine and Serge, 1991; Habeeb *et al*., 1992; and Terlouw, *et al*., 1997). The 2nd reason may be attributed with the decreasing in fertile egg, fertile eggs produced from battery cages had significantly lower yolk index and shell thickness than fertile eggs produced from floor pens. The last reason may be attributed to the plumage damage in males which might be mainly returned to higher aggressive activity. Increasing aggressive activity between males may be due to decrease number of mating frequency between males and females. All these reasons might be produced weakness embryos and increases embryonic mortality and decreases hatchability percent.

4. Egg quality traits:

The effects of housing system on egg quality traits (egg shape index, yolk index, internal quality unit and shell thickness) are presented in Table (4). Eggs laid on floor had higher yolk index values than those eggs laid on cages at 18 weeks of age. On the other hand, shell thickness was insignificantly higher in eggs laid on floor than those laid on cages during the study period. Also, internal quality unit values were insignificantly varies due to housing system. These results similar those obtained by Ozbey and Esen (2007) who reported that floor and cage housing systems have essential effects on egg quality characteristics of Rock Partridges. Haugh unit values were higher ($P<0.05$) in caged birds than those on floor group. However, yolk index values were significantly ($P<0.05$) higher on floor than in the cage system. Hidalogo *et al*. (2007) reported that the eggs produced on floor had higher shell thickness and lower Haugh unit than produced in cage of laying hens. He added that, floor and cage housing systems had no effect on shape index of quail eggs.

5- Plumage conditions:

Plumage condition scores of male and female quails as affected by different housing systems are given in Table (5). High plumage scores (indicate high plumage deterioration) were obtained in males housed in cages than other housed on floor at all ages with significant differences ($P<0.05$) except at 18 weeks of age. This result indicated that, housing

system had a direct effect on behavioral activity of birds especially males. The males housed on floor pens had lower plumage damage than those housed on battery cages. Plumage damage might be mainly attributed to higher aggressive activity.

On the hand, there were significant differences ($P<0.05$) between the two housing systems due to advancing ages at 14 and 18 weeks. These results indicted that plumage condition scores increased with advanced age especially in females than in males, when males and females raised together.

6- The area of the cloacal gland (mm^2):

The area of the cloacae gland (mm^2) of male quails as affected by different housing systems is presented in Table (6). Males housed in cages had significantly ($P<0.05$) higher cloacal gland area than males housing on floor pens at 8 and 10 and during the entire period from 8 to 18 weeks of age,

These results indicate that housing system had significantly effects on cloacal gland area (mm^2) and testicular development. These results agreed with Sachs (1967) and Siopes and Wilson (1975) who reported that the area of the cloacal gland is a good indicator of testicular size and function. Increasing in cloacal gland area in males kept in cages than those on floor cleared by plumage conditions. Battery cages caused increase plumage damage. Increasing aggressive activity between males may be due to decrease number of mating frequency between males and females which cause increase cloacal gland foam and size.

7-Mortality rate:

Average mortality rate of Japanese quail males and females as affected by housing system are presented in Table (7). Battery cages exerted adversive effect on mortality rate. Birds housed in cages had higher mortality rate than birds housed in pens (10.00 vs. 2.22 %, respectively) irrespective of sex. On the other hand, the males had higher mortality rate than the females (16.67 vs. 0.83 %, respectively) irrespective of housing system.

In general high significant differences ($P<0.01$) were detected between housing systems on most studied traits. It was concluded that battery cages had significant adverse effects on most productive and reproductive traits compared to floor pens. In this respect, floor pens system could be recommended to increase Japanese quail breeder's performance.

Table (1): Body weight (g) of male and female quails at different ages as affected by different housing systems (Mean±SE)

Age (wks)	Sex	Housing system	
		Floor pens	Battery cages
6	Male	233.08±7.89	232.50±9.78
	Female	244.23±5.58	249.75±7.08
	Overall	238.66±4.83	241.13±6.12
8	Male	229.50±6.73[b]	240.20±8.52[a]
	Female	271.44±4.76[b]	282.60±6.02[a]
	Overall	250.47±4.12[b]	261.40±5.22[a]
10	Male	204.00±9.05[b]	245.80±11.44[a]
	Female	271.75±6.40[b]	286.90±8.09[a]
	Overall	237.88±5.54[b]	266.35±7.01[a]
14	Male	229.13±8.02[b]	244.60±10.14[a]
	Female	295.31±5.69	292.78±7.56
	Overall	262.22±4.91	268.69±6.32
18	Male	233.88±8.14[b]	262.00±10.30[a]
	Female	301.00±5.76	307.78±7.67
	Overall	267.44±4.98[b]	284.89±6.42[a]

[a,b,c] Means in any row with no common superscript differ ($P < 0.05$).

Table (2): Egg production traits as affected by housing systems through 6 to 18 weeks of age (Mean±SE)

Parameters	Housing systems	
	Floor pens	Battery cages
Egg number/hen (n)	60.50±3.27[a]	49.01±3.27[b]
Laying rate (%)	72.04±2.09[a]	57.69±2.09[b]
Egg weight/hen (g)	13.51±0.24[a]	12.75±0.24[b]
Egg mass/hen (g)	816.20±41.60[a]	623.36±41.60[b]

[a,b] Means in any row with no common superscript differ ($P < 0.05$).

Table (3): Fertility, hatchability and embryonic mortality percentages of quail eggs as affected by housing systems through 8 to 18 weeks of age (Mean±SE)

Parameters	Housing systems	
	Floor pens	Battery cages
Fertility (F) %	97.89±1.32	97.50±1.39
Hatchability (H) %	73.44±4.37	60.88±4.63
Early dead embryo (EDE) %	6.14±1.54[b]	13.67±1.66[a]
Late dead embryo (LDE) %	16.88±4.51	23.57±4.82
Dead in shell (DIS) %	4.11±1.77	2.38±1.88
Pipped (PIP) %	4.44±2.99	7.50±3.18
Total dead embryo (TDE) %	26.56±4.37	39.13±4.63

[a,b] Means in any row with no common superscript differ ($P \leq 0.05$).

Table (4): Egg quality traits with respect to different housing systems (Mean±SE)

Parameters	Age (wks)	Housing system	
		Floor pens	Battery cages
Egg shape index (ESI)	14	79.00±0.64	80.44±0.74
	18	79.22±0.74	77.80±0.99
	Overall	79.11±0.49	79.12±0.62
Yolk index (YI)	14	49.00±0.82	47.22±0.95
	18	50.78±0.95[a]	46.00±1.27[b]
	Overall	49.89±0.63	46.61±0.79
Internal quality unit (IQU)	14	90.42±1.14	93.67±1.31
	18	94.56±1.31	94.80±1.76
	Overall	92.49±0.87	94.23±1.01
Shell thickness (STH)	14	19.92±0.62	19.67±0.71
	18	20.00±0.71	18.80±0.96
	Overall	19.96±0.47	19.23±0.60

[a,b] Means in any row with no common superscript differ (P < 0.05).

Table (5): Plumage condition (scores)[1] of male and female quail with respect to different housing systems (Mean±SE)

Age (wks)	Sex	Housing systems		Overall of sex
		Floor pens	Battery cages	
8	Male	4.13±0.59[b]	6.60±0.76[a]	5.36±0.68[A]
	Female	4.63±0.42	3.80±0.53	4.21±0.48[B]
	Overall	4.38±0.36	5.20±0.46	
10	Male	7.00±0.76[b]	10.20±0.95[a]	8.60±0.86[A]
	Female	4.81±0.53	4.50±0.68	4.67±0.61[B]
	Overall	5.91±0.46[b]	7.35±0.59[a]	
14	Male	9.75±0.83[b]	12.20±1.04[a]	10.98±0.94[A]
	Female	6.06±0.58[b]	7.44±0.78[a]	6.75±0.68[B]
	Overall	7.91±0.51[b]	9.82±0.65[a]	
18	Male	11.25±1.15	11.60±1.46	11.43±1.31[A]
	Female	9.56±0.81[b]	10.44±1.09[a]	10.00±0.95[B]
	Overall	10.41±0.71[b]	11.02±0.91[a]	
Overall of housing	Male	8.00±0.48[b]	10.40±0.60[a]	9.20±0.54[A]
	Female	6.38±0.34	6.10±0.43	6.24±0.39[B]
	Overall	7.19±0.29[b]	8.25±0.37[a]	

[a, b] Means in a row with no common superscript differ (P < 0.05).

[A,B] Means in a column with no common superscript differ (P < 0.05).

[1]High score indicate high plumage deterioration.

Table (6): The area of cloacal gland (mm^2) of males as affected by different housing systems (Mean±SE)

Age (wks)	Housing systems	
	Floor pens	**Battery cages**
8	441.00±15.86[b]	531.20±20.06[a]
10	397.38±32.57[b]	559.20±41.10[a]
14	410.75±33.18	503.80±41.96
18	457.75±31.16	516.40±39.41
Overall	422.38±10.44[b]	528.00±13.21[a]

[a,b] Means in any row with no common superscript differ (P < 0.05).

Table (7): Total mortality rate as affected by housing system

	Sex	**Housing system**		
		Floor pens	**Battery cages**	**Total**
Mortality 6-18 (wks)	Male %	6.67	26.67	16.67
	Female %	0.00	1.67	0.83
Total mortality	%	2.22	10.00	6.11

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الملخص العربى

تأثير نظامين للإسكان على الصفات الإنتاجية والتناسلية فى السمان اليابانى

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أجريت هذه التجربه لدراسة تأثير نظامين من التسكين (التربية الأرضية – التربية فى بطاريات) على الصفات الإنتاجية والتناسلية فى السمان اليابانى.

تم أستخدام 180 طائراً عند 6 اسابيع من العمر حيث وزنت فردياً ووزعت عشوائياً الى مجموعتين تجريبيين متساويتين فى العدد وفقاً لنظام التسكين (90 طائراً / مجموعة 30 ذكر : 60 أنثى) وكل مجموعة وزعت عشوائياً على 3 مكررات.

- تم تسجيل كلٍ من وزن الجسم ، إنتاج البيض ، نسبة النفوق. كما تم حساب نسب الخصوبه ، الفقس والنفوق الجنينى. كما تم تقدير كلٍ من جودة البيض ، حالة ال تويبش ، مساحة الغدة فوق المجمع وذلك خلال فترة التجربة.

- أظهرت النتائج وجود فروق عالية المعنويه ($P\leq0.05$) بين نظامى التسكين فى معظم الصفات المدروسه.

- وجد أن استخدام نظام التربية الأرضى للسمان البياض حسن من معظم الصفات المدروسه والتى تتمثل فى: معدل إنتاج البيض، عدد ووزن البيض، كتلة البيض، نسبة الفقس والنفوق الجنينى، دليل شكل الصفار – سمك القشرة – الجودة الداخلية للبياض مقارنة بالتربية فى أقفاص.

وعلى العكس من ذلك وجد أن استخدام البطاريات فى تربية السمان البياض أدى إلى زيادة كلٍ من وزن الجسم، تلف الريش، مساحة الغدة فوق المجمع، معدل النفوق الكلى مقارنة بالتربية الأرضية خلال فترة التجربة.

وخلاصة هذه الدراسة توضح أن إستخدام نظام التربية الأرضية له تأثير معنوى وإيجابى على معظم الصفات الإنتاجية والتناسلية للسمان اليابانى البياض مقارنة بالتربية فى بطاريات.