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Effect of Self-photoperiod on Live Weight, Carcass and Growth Traits in Quails (*Coturnix Coturnix Japonica*)

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ABSTRACT : The weekly liveweight gain, growing and stress parameters of quails bred using two different types of lighting for 6 weeks following hatching were examined in this study. The first type of lighting was 23 L:1 D, continuous lighting (CL), widely used in the commercial system and the second was a self-photoperiod (SP) system consisting of a continuously lit chamber and a dark chamber the quails could move to as they wished. On the first 15 days, no difference was found in liveweight gain between the two breeding systems. On the 6th week when the trial was completed, the liveweight of the male quails upon which CL lighting was used was 159.03 g while the weight of males in the SP group was 174.43 g; these values in female quails of the CL group were 179.15 g and in the SP group were 200.68 g. The CL group had lower testis volume (TVOM, cm^3) and testis weight (TW, g) than the SP group, however there was no difference between the groups in testis weight/body weight rate (BWTW %). In female quails, the ovary weight (OW, g) and the ovary weight/body weight rate (BWOW, %) values were higher in the SP group. The CL light regime was concluded to cause stress in male quails (CL, Heterophil/Lymphocyte ratio (H/L): 0.27; SP, H/L: 0.17). In conclusion; the SP system allowing the quails to regulate their light periods increased liveweight gain and enabled sexual maturity to be gained at an earlier period than in quail on the CL system and improved their welfare. (**Key Words :** Lighting, Quail, Live Weight, Growth, Stress)

INTRODUCTION

Environmental factors such as feeding, management, ambient temperature, density and lighting regime are known to affect production, health and welfare of poultry (Donkoh, 1989; Moller et al., 1995; Sarica, 1998; Chen et al., 2002).

The difference between day and night increases from the equator towards the poles, with nights getting longer in winter and shorter in summer seasons. Animals have become adapted to the seasons of their environment by responding to the changes in the lengths of daylight and night in preparation for the climatic changes that are to come. These responses, which are associated with the seasons of the year, involve physiological processes known as *photoperiodism* (Koukkari and Robert, 2006).

The color, intensity and period of the light used in poultry production cause physiological interactions in birds, affecting their breeding, growth and attainment of sexual maturity (Perera and Follett, 1992; Mills et al., 1997). Buyse et al. (1996) also reported that increase in lighting intensity causes aggressive behaviors and cannibalism in caged birds.

The lighting regime, widely used over birds bred for meat, usually involves 24 h or 23 h light and 1h of dark periods (Nicholson, 1998). Morris (1967) stated that continuous or near continuous lighting will cause early and maximum growth in poultry. However, darkness is as important as lighting for the health of the birds. Moller et al. (1999) reported that the asymmetry of the thickness and length of tarso-metatarsus, tonic immobility and gait scores were higher in continuously lit establishments than in those with intermittent lighting. MacDaniel (1972), on the other hand, stated that intermittent lighting allowed for higher liveweight increase than continuous lighting. Further, Moore and Siopes (2000) stated that the increase of melatonin release strengthens the immune systems of quails. Gordon (1994) reported that a 16 h-lighting decreased stress in broilers, thus allowing for more live weight increase.

Japanese quails reach puberty at about 33 days of age and attain full adult function within 2-3 weeks, with females maturing slightly earlier than males. Longer days

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were found to stimulate gonadal growth, prompt gonadotropin production and release, and increase the level of plasma sex hormones of quails (Mills et al., 1997).

The aim of this study was to allow the quails to self-determine their photoperiods and to compare some performance and stress traits between self-photoperiod and a commercial lighting method. In order to examine the utility of the self-photoperiod mechanism, it was compared with the continuous lighting system widely used in commercial broiler production. Thus, the effect of two different lighting methods was investigated on the live weight gain, carcass traits and reproductive organ development of quails and their heterophil/lymphocyte (H/L) ratio, as a stress parameter.

MATERIALS AND METHODS

This research was carried out in the Quail Breeding Unit of the Veterinary College in Ataturk University, Turkey. In the trial design, a cage of 180 cm×90 cm×50 cm was used for the quails of the continuous lighting (CL) group, a lighting space of 90 cm×90 cm×50 cm was provided for the self-photoperiod (SP) group, and a dark chamber of 90 cm×90 cm×50 cm was supplied for the quails to enter at their will; the dark and light chambers were separated by a canvas and the other parts of the dark chamber were covered with a black cloth to avoid light. For each group, chicks were randomly selected upon hatching and a total of 174 quails were used with 87 quails in each of the CL and SP groups. However, one quail from the CL group and two quails from the SP group died in the first week of the trial. Animals were cared for in accordance with the Canadian Council on Animal Care guidelines (CCAC, 1993) for the duration of the trial.

In the CL group, the lighting regime of the cage was 24 L:0 D for the first three days and 23 L:1 D from then until the end of the trial (3^{rd}-43^{rd} days); in the SP group, it was 24 L:0 D throughout the trial in the lighted chamber.

The temperature of both cages was 30°C for the first week and dropped 2°C every day to a steady temperature of 20°C. During the first two weeks, the broiler starting feed (84.91% DM, 23.00% CP, 2,858.00 kcal/kg of DM, 3.18% Ether extract, 3.51% Ash, 1.50% Ca, 1.76% P) and afterwards the broiler finishing feed (85.27% DM, 18.00% CP, 2,811.52 kcal/kg of DM, 3.33% Ether extract, 5.56% Ash, 1.50% Ca, 0.65% P) and water were provided *ad libitum*.

The quails were weighed weekly to determine the change in their weights. On day 21, sexes were determined by the breast feathers and coded (43 males and 43 females in CL group; 40 males and 45 females in SP group), weighed and recorded. Both groups were equally fed at the same hour of the day, weekly excess feed was collected to determine the amount of consumed feed.

At the end of the trial, 10 males and 10 females from each group, totaling 40 quails, were killed by cervical dislocation and blood samples were collected, carcass traits were examined and the dissections required for the genital organs were made.

The blood weight was calculated for each quail by determining the pre- and post-slaughter weights and subtracting the later from the former. The head, inedible innards, gizzard, liver and feet were separated from the carcass, weighed and recorded. The dressing percentage (hot) was determined by the comparison of carcass weight with pre-slaughter weight.

Two preparations for each bird were made from the blood samples, 1 drop being smeared on each of 2 glass slides. The smears were stained using May-Grünwald and Giemsa stains (Lucas and Jamroz, 1961), approximately 2 to 4 h after methyl alcohol fixation. One hundred leukocytes, including granular (heterophils, eosinophils and basophils) and nongranular (lymphocytes and monocytes), were counted per slide for each bird. The average counts of the two preparations for each bird was taken to determine the Heterophils, Lymphocytes and H/L ratio.

Testis weight (TW) and ovary weight (OW) were determined after they were removed by blunt dissection. Body weight (BW) and both TW and OW measurements were made using digital scales that weighed to the nearest 0.01 and 0.001 g, respectively. Each bird's testis/body weight ratio (TWBW) was determined by the equation, (TW/BW)×100. The ovary weight/body weight ratio (OWBW) was determined by the equation: (OW/BW)×100. The width, height and depth of the testis were measured by calipers and the testis volume (TOV) was calculated by the following formula;

TOV = testis height×testis width×testis depth

The width (lateral) and height (dorsoventral) of the cloacal gland were measured to the nearest 0.01 mm using vernier calipers. The product of height and width in mm^2 was used as an index of gland size as described by Siopes and Wilson (1975).

Student's *t*-test was used when comparing the two groups. Statements of statistical significance were based on $p \leq 0.05$.

RESULTS

Following the six-week trial period, the male and female quails in the CL group recorded a liveweight increase of 158.25 g with an average feed intake of 789.9 g, while in the SP group a liveweight of 176.09 g with 814.8 g of feed intake were recorded. Feed efficiency ratio was

Table 1. Average feed consumption, live weight gain and feed efficiency ratio for CL and SP groups obtained at the end of the experiment

Groups*	AFC (g)	ALWG (g)	FER (g/g)
CL	789.9	158.25	4.99
SP	814.8	176.09	4.63

* CL = Continuous lighting group; SP = Self-photoperiod group.
AFC = Average feed consumption, ALWG = Average live weight gain, FER = Feed efficiency ratio.

calculated as 4.99 in the CL group and 4.63 in SP (Table 1).

The average and standard error values of liveweight of the birds at day 21, when the sex was determined via breast feathers, are given in Table 2. The intergroup differences of the data sets comparing CL and SP groups were considered non-significant ($p>0.05$). The measurements from day 21 to the end of week 6 showed that the lighting system influenced liveweight ($p<0.01$) and that the male quails of the SP system were heavier after day 21 (Table 3). The weights of the female quails were similar in both lighting systems until day 36; however, on the last week of the experiment the weights of the females in SP group were higher than the CL group ($p<0.01$), (Table 3).

The lighting systems had no influence over the male quails' carcass traits but the weights of the inedible innards and livers of the female quails in the SP group were higher ($p<0.01$). A higher dressing percentage (hot) was obtained from the female quails of the CL group ($p<0.05$) (Table 4).

Table 2. Liveweight (g) of the quails between days 1-15

Groups*	1 d	8 d	15 d
CL	10.84±0.46	28.18±0.60	60.36±1.50
SP	11.47±0.20	27.71±0.60	60.00±1.35
t_{169} P	0.207	0.578	0.855

* CL = Continuous lighting group; SP = Self-photoperiod group.

Table 5 shows that the number of lymphocytes was lower and the number of heterophils was higher for the quails in the 23 L:1 D system. Thus, the H/L ratioe was higher under this type of lighting. However, these differences were significant only for males ($p<0.05$).

The average of the TVOM, TW, BWTW and CG measurements used as criteria for the male quails reaching sexual maturity were respectively determined as 1.02, 1.96, 1.32 and 0.15 for the CL group and 2.82, 3.43, 1.81 and 0.21 for the SP group. The differences between all traits except for BWTW were significant (Table 6).

Comparison of the average OW and BWOW and CG

Table 3. Liveweight (g) of male and female quails between days 16-43

	Groups*	22 d	29 d	36 d	43 d
Male	CL	73.68±2.16	99.08±4.64	149.86±2.62	159.03±2.34
	SP	84.45±2.10	125.45±3.25	167.91±4.04	174.43±4.14
	t_{81} P	0.001	0.000	0.000	0.001
Female	CL	81.51±3.28	116.23±2.98	166.44±3.03	179.15±3.15
	SP	80.03±2.70	120.61±3.81	175.55±3.64	200.68±4.35
	t_{86} P	0.734	0.372	0.061	0.000

* CL = Continuous lighting group; SP = Self-photoperiod group.

Table 4. Carcass traits of male and female quails

	Groups*	BW (g)	HW (g)	IW (g)	GW (g)	LW (g)	TW (g)	HEW (g)	DP (%)
Male	CL	5.4±0.5	7.3±0.4	13.4±0.7	2.7±1.5	3.5±0.2	2.9±0.0	1.0±0.1	60.4±1.2
	SP	5.4±0.6	8.2±0.4	12.5±0.8	1.8±0.5	3.6±0.3	3.1±0.1	1.3±0.1	60.0±1.5
	T_8P	0.969	0.182	0.432	0.073	0.760	0.176	0.053	0.847
Female	CL	5.4±0.5	7.8±0.3	15.4±1.1	1.9±0.3	4.7±0.2	3.5±0.2	1.3±0.2	63.1±1.0
	SP	5.4±0.6	8.6±0.3	22.0±1.6	2.2±0.4	6.0±0.3	3.9±0.1	1.6±0.1	58.5±1.7
	t_8 P	0.956	0.082	0.009	0.508	0.007	0.076	0.127	0.048

* CL = Continuous lighting group SP; = Self-photoperiod group.
BW = Blood weight, HW = Head weight, IW = Inedible weight, GW = Gizzard weight.
LW = Liver weight, HEW = Heart weight, TW = Toe weight, DP = Dressing percentage (hot).

Table 5. Average lymphocyte, heterophil and H/L ratios (±SEM) of male and female quails in CL and SP groups

	Groups*	Lymphocyte (%)	Heterophil (%)	H/L ratio
Male	CL	79.44±2.14	20.56±2.14	0.27±0.03
	SP	85.98±1.81	14.02±1.81	0.17± 0.03
	T_8 P	0.036	0.004	0.008
Female	CL	62.95±4.35	37.05±4.35	0.63±0.12
	SP	64.24±372	35.76±3.72	0.60±0.11
	t_8 P	0.860	0.646	0.854

* CL = Continuous lighting group; SP = Self-photoperiod group.

Table 6. Average TVOM (cm^3), TW(g), BWTW (%) and CG (cm^2) values (±SEM) of CL and SP groups

Groups*	TVOM (cm^3)	TW (g)	BWTW (%)	CG (cm^2)
CL	1.02±0.75	1.96±0.23	1.32±0.15	0.15±0.01
SP	2.82±1.10	3.43±0.55	1.81±0.34	0.21±0.02
t_8 P	0.034	0.021	0.210	0.042

* CL = Continuous lighting group; SP = Self-photoperiod group.
TVOM = Testis volume, TW = Testis weight, BWTW = Testis/body weight rate, CG = Cloacal gland area.

Table 7. Average OW (g), BWOW (%) and CG (cm^2) values (±SEM) of CL and SP groups

Groups*	OW (g)	BWOW (%)	CG (cm^2)
CL	0.84±0.44	0.50±0.26	0.17±0.05
SP	4.98±3.41	2.41±1.63	0.22±0.06
t_8 P	0.004	0.005	0.086

* CL = Continuous lighting group; SP = Self-photoperiod group.
OW = Ovary weight, BWOW = Ovary/body weight rate, CG = Cloacal gland area.

values of female quails in the CL and SP groups showed that these were higher for the self-photoperiod treatment. However, athough the CG area of the self-photoperiod group was larger than the 23 L:1 D group, this difference was non-significant ($p>0.05$) (Table 7).

DISCUSSION

In this study, it was determined that the animals in the SP group, where the quails self-determined their photoperiods, reached the same liveweight in only 5 weeks that the other group (CL) reached in 6 weeks (Table 3). The SP system is a somewhat intermittent lighting programme in which the quails fix the dark phase period and frequency by instinct. Thus, the quails avoid the stress of continuous lighting and with the opportunity of access to feed all day long, an advantage of continuous lighting, a higher liveweight is assumed to be reached. Buyse et al. (1996) stated that intermittent lighting may provide a final weight similar to or better than continuous lighting. However, in a study examining the influence of five different lighting regimes, Boon et al. (2000) found that liveweight gain declined with decrease of photoperiod, the effect being more influential in female quails. Lewis et al. (1998) reported that when chicks were reared in light-proof rooms with short photoperiods, their food intake and growth rate may be reduced in comparison with long-day treatments. Ozcan and Akcapinar (1993) stated that continuous lighting would provide the highest liveweight gain for quails. Rozenboim et al. (1999), however, determined that their trial lighting regime, installed as 23 L:1 D, increasing (16 L:8 D) and increasing (16:8P), was not influential over growth until day 42. The live weight of the males lighted for 49 days was lower and, contrary to this, the continuously lighted females were heavier. Nonetheless, in another study comparing the intermittent and continuous lighting of quails, the lighting programme used had no influence on liveweight (Sarica, 1998). Similar results were obtained in studies on broilers (Malleau et al., 2007).

In this study, the yield values of the CL group female quails were higher. Sarica (1998) reported that the animals in an intermittent lighting group yielded more than those in continuous lighting. However, he recorded no differences in eatable organ weights. In another study, the increase of lighting period reduced the ratio of inedible innards (Ozcan and Akcapinar, 1993). The reason for lower dressing percentage (hot) in the female quails in the SP group is thought to result from the higher weights of the inedible innards, liver and ovaries of the animals in this group.

Wilson (1972) stated that in younger quails the spermatogenic phase was closely related to the testis weight which had to exceed 1,000 mg for full spermatogenic activity. In the present study, the testis weight and volume were lower in the continuously lit quails than in the SP group; however, Follett and Maung (1978) reported that testis growth increased in proportion to the increase of lighting period and FSH release. The reason that the CL group, compulsorily receiving more light, had higher TVOM and TW (g) values than the SP group is thought to be that continuous lighting caused the birds to be stressed. The conclusions of Satterlee and Marin (2004) that, upon classification of the quails into high-stress and low-stress groups, the testis weight and BWTW of quails in the low-stress group were lower supports the conclusions from this study. Cloacal gland (CG) is a determinant of sexual activity rate in male quails (Wilson, 1972). In this study, the CG in male quails of the SP group was found to be higher. However, when Satterlee and Marin (2004) applied the lighting programmes of 14 L:10 D until 29 weeks of age, then 8 L:16 D for 3 weeks and, the 14 L:10 D programme again after week 32, GC dropped upon the shortening of lighting period and increased upon the elongation of this period.

Although the lighting programme of 23 L:1 D was not used on the quails laying eggs, the ovary weight and BWOW (%) values, an indication of growth in female quails, were found to be high in the SP treatment. Nevertheless, Tanaka et al. (1965) reported that lighting periods below 12 h did not cause a difference in ovary weights but, upon lighting for 14 h or more, the increase in daily lighting also increased the ovary weight. Lewis et al. (2001) discovered that in the lighting periods applied for

chickens as 8 L:16 D, 8 L:8 dim:8 D, 8 dim, 8 L:8 D and 16 L:8 D, the first period of laying eggs was the shortest for the chickens lit for 16 h.

In birds, the H/L ratio is used as a stress indicator (Gross and Siegel, 1983; Onbasilar et al., 2007). In this study, H/L ratio of both sexes in the CL group was found to be higher. However, only the difference between male quails was found to be significant ($p<0.05$). Thus, the commercially used CL system is thought to cause stress in male quails. Likewise, Moore and Siopes (2000) found that the H/L ratio was highest in continuously lit quails. In a previous study, where two lighting programmes CL and 14 L: 10 D were compared, it was determined that the number of heterophils increased and the number of lymphocytes decreased, showing that the chickens were stressed due to continuous lighting (Campo et al., 2007). Further, higher standard error values for the heterophils, lymphocytes and H/L average in quails of the CL group compared to the SP system suggests the presence of individual variation in the need of darkness.

In conclusion, with quails given the opportunity to self-determine their photoperiods, a higher liveweight gain may be achieved. With the SP system, the welfare of the quails may be better and they may gain sexual maturity earlier than those under CL. Further, breeding costs may drop since only half of the space used in breeding is allocated to lighting.

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