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Effect of Artificial and Natural Day Light Intensities on some Behavioral Activities, Plumage Conditions, Productive and Physiological Changes for Japanese Quail

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ABSTRACT

This study was designed to evaluate the effects of different artificial light intensity; 10, 50, 250, 500 lux and natural day light (NDL, average 375 lux) from 3-18 week of age on behavioral activities, plumage conditions, productive and physiological traits for grower and layer of Japanese quail. A total of 270 Japanese quails chicks (3 week old) were randomly assigned to five treatment groups according to different light intensities. The results showed that the birds subjected at NDL and 250 lux spent significantly more time standing than those recorded in 50 and 500 lux groups. Also, birds kept at 500 lux spent significantly more time walking compared with other groups. The lowest plumage deterioration was detected in birds kept under NDL compared with other experimental groups. The heavier body weight ($p \leq 0.05$) at 6 weeks and weight gain from 3-6 weeks were detected for birds reared at NDL and 250 lux compared with 500 lux and did not significant with the rest of the experimental groups. While, Hen Day Egg Production (HDEP) and Total Egg Mass (TEM) were linearly increased beginning of 50 lux with increasing light intensity. Fertility percentage was significantly higher in 250 lux group than in 50 lux and was not significant with the other groups. Hatchability percentage was significantly decreased in 10 lux group compared with the other groups. Serum level of T_3 was decreased linearly with increasing light intensity. Birds kept at 500 lux had reduced overall number of Ovarian Yellow Follicle (OYF), relative weight of ovaries and testes and cloacal gland area compared with the other groups. From our results, it could be concluded that neither high light intensity (500 lux) nor low light intensity (10 lux) had a positive effect on most traits. Therefore, to maximize productive, reproductive parameters and increase revenue economic may be by using moderate artificial light intensity if we used closed-side housing system or NDL if we used open side housing system for production of Japanese quail.

Key words: Artificial light intensity, natural day light, productive performance, physiological traits, Japanese quail

INTRODUCTION

Natural or artificial light is one of the environmental or managerial factors which play an important role to regulate poultry production, reproduction and welfare by modulating various behavioral and physiological pathways of birds (Prescott *et al.*, 2004; Deep *et al.*, 2010). Light stimulate gonadal development, eventually resulting in onset of lay by stimulate the hypothalamus area via eyes or by pineal gland to release GnRH, which stimulate anterior pituitary to release FSH and LH (Chen *et al*., 2005). These hormones are responsible for production of the major sex steroid hormone such as testosterone, estrogen and progesterone. Estrogen is necessary for yolk precursor lipoprotein secretion by the liver and oviduct and follicle development (Dawson, 2005). Also, light stimulate increase secretion of metabolic hormones (T_3, T_4, insulin, GH and IGF-1). All these hormones shared in development and enhancing productive and reproductive functions of domestic birds (Mateescu and Thonney, 2005). Light is consists of three different aspects: photoperiod, color and intensity (Lewis and Morris, 1998). There has been much workers focused on the effects of light intensity on different poultry species; laying hens (Lewis *et al*., 2004), broilers (Ahmad *et al*., 2011) and turkeys (Yahav *et al*., 2000) in different aspects such as: production (Lien *et al*., 2007), behaviour (Alvino *et al*., 2009), physiology (Lewis *et al*., 2005), vision (Prescott *et al*., 2003) and welfare (Deep *et al*., 2010).

Some of these studies have been reported that a positive correlation between low light levels and better broiler performance (Downs *et al*., 2006). Low light levels usually decrease physical activity resulting in more resting and sleeping and therefore faster weight gain. Also, low light intensity is thought to help reduce cannibalism and pecking behavior (Blatchford *et al*., 2009). In contrast, scientific research has been shown that, light intensity ranging from 1-151 lux has been found to not affect body weight, Feed Intake (FI) and Feed Conversion (FC) in broiler chickens (Kristensen *et al*., 2006; Lien *et al*., 2007).

In relation to egg production; hen-housed egg production improved in birds kept at 5 and 50 lux compared with 1 and 500 lux. Also, ovary weights, oviduct weight and ovarian large yellow follicles increased with increasing light intensity, when commercial layers exposed to different light intensity from 18-45 weeks of age (Renema *et al*., 2001a, b). In contrast, no significant differences in egg production were observed with light intensity ranged from 2-45 lux (Hill *et al*., 1988) and in sexual maturity (Renema *et al*., 2001a).

The current study was designed to compare the effects of artificial and natural day light intensity on behavioral activities, plumage conditions, productive and physiological changes for grower and layer of Japanese quail.

MATERIALS AND METHODS

Birds, housing and treatments: The present study was carried out at the Poultry Farm, Department of Animal Production, Faculty of Agriculture, Suez Canal University, Ismailia, Egypt, during spring season. After hatching all quail chicks were kept under normal brooding conditions in brooding floor pens until they were 3 weeks of age. Lighting program was artificially continuous by tungsten lamp from hatching to 3 week old, after that the light was changed to give 16L-8D. This regime was maintained until the end of the experiment. The light intensity during the first 3 weeks of rearing phase ranged from 50-60 lux. At 3 week old, 270 chicks were weighed individually and randomly distributed into 5 experimental groups (54 chicks each, 36 females+18 males) of three replicates each for 10, 50, 250 and 500 lux and Natural Day Light (NDL), respectively. Natural day light was approximately 12±0.5 h day^{-1} and completed with artificial tungsten light 4±0.5 h to complete 16 h L/D. The average light intensity for natural day light group was 375 lux, which estimated as an average of different light intensity through the day for all experimental period as following: 195.7 lux from 6-12 am, 885.6 from 1-4 pm, 360.4 from 5-7 pm and 60.8 from 8-10 pm. Light intensity was measured with a light meter (lux-meter) to produce the photometric unit “lux” in level of the head of birds (Lewis and Morris, 2006). Tungsten lamps were used; each lamp was set in the ceiling of each cage to obtain the requirement of light intensity (10, 20, 40 and 60 watt, to get experimental light intensity, respectively). The pens used for artificial light intensity were completely dark.

All treatments groups were distributed into 15 housing cages from galvanized metal (100×50×50 cm), 18 birds/cage, with sex ratio 1:2. Ambient temperature and relative humidity inside experimental cages were recorded daily during the experimental period by using thermometer and hygrometer. Average ambient temperature was 23.72±2.53°C and relative humidity was 48.28±3.45%. All birds were fed a conventional corn and soybean meal basal diet, formulated to meet all the nutritional requirements of quail birds according to specifications of the NRC (1994). The rations contained 24% CP (growing period) and 20% CP (laying period) with 3000 Kcal kg^{-1} (ME) in both periods. Both feed and water were provided *ad libitum* in all experimental groups. In order to calculate feed conversion to egg production, calibration trait for male intake was done at the same time and same house for both groups. So, the amount of feed consumed per male was subtracted from the feed consumed by the cage.

Studied traits

Behavioral activities: The behavioral activities traits were determined at 8, 10, 12 and 14 weeks of age using a video camera. The behavioral activities traits were recorded for 1 h day^{-1} during the morning from 9-12 am. The following traits were determined for each 5 min interval (sampling time). Basic activities were observed (number of birds standing, sitting or walking) and additional activities were recorded (number of birds feeding, drinking or preening). Numbers of observations were calculated as a percentage of birds observed for each trait (Mekawy, 2014).

Plumage conditions: Plumage deterioration scores for male and female quails were investigated visually at 6 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 Khalil *et al*. (2012). Also, total mortality rate were recorded throughout the experimental period.

Productive, reproduction and physiological traits: Individual live body weights and FI were recorded weekly from 3-6 weeks of age. Body weight gain and FC were calculated during the same period. Daily egg numbers and weekly egg weight were recorded up to 18 weeks of age. Also, age at 50% egg production, Hen Day Egg Production (HDEP) and Total Egg Mass (TEM) were calculated. A total of 1300 hatching eggs were used to determine fertility (F%) and hatchability (H%) for all groups at 8, 12 and 16 weeks of age. Hatching eggs were collected daily and stored at 18°C and 65% RH 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 according to Khalil (2009). The cloacal gland areas (height and width per mM) were measured by using a calliper for the males at 8, 10, 14 and 18 weeks (Khalil *et al*., 2012).

At 6 and 18 weeks of age, 60 birds (30 males and 30 females) from all groups were weighed and slaughtered by slitting the jugular vein. Ovarian morphology was investigated and numbers of yellow follicles were counted. Testes, ovaries and oviducts were removed and weighed using an electronic analytical scale, also oviducts length were recorded.

The blood samples were collected during slaughtering and then centrifuged at 3000 rpm for 20 min and serum obtained were stored at -20°C for further analysis. Serum T_3 concentrations were determined by ELISA kits manufactured by Padtan Elm Co., Tehran, Iran. The intra and inter-assay CVs of the assays were 12.6 and 13.2%, respectively. The sensitivity of the test was 0.2 ng mL^{-1}.

Statistical analysis: Data were analyzed using the General Linear Model (GLM) procedure of SAS Institute Inc. (SAS., 2001). Differences among means were detected using Duncan's new multiple test (Duncan, 1955). Correlation coefficients among traits were estimated.

RESULTS

Behavioral activities, plumage conditions and mortality rates: The results in Table 1 showed that the birds subjected at NDL and 250 lux had significantly spent more time standing than those recorded in 50 and 500 lux groups. Also, the birds kept at 500 lux had a significantly spent more time walking compared with other groups. The highest time of sitting was obtained in birds kept at 50 lux, but the shortest value was recorded in 250 lux group. Also, the longest time of preening percent was obtained in birds kept at NDL, but the lowest value was recorded in 50 lux group. However, light intensity did not significantly affected on the feeding and drinking behavior. Moreover, the results showed significant differences among treatments in plumage conditions. The highest plumage deterioration of the males was recorded in 50 lux group, but the lowest value was recorded in NDL group. Also, plumage deterioration was significantly decreased in females kept under NDL compared with the other groups, except with 250 lux the difference was not significant. In relation to overall means, the lowest value was obtained in birds reared under NDL than those recorded in other treatment groups. In the same context, the results indicated that males had significantly higher plumage deterioration than females throughout the experimental period, irrespective of treatments. Moreover, mortality rate was significantly decreased in birds subjected at 500 lux compared with 50 lux group and was not significant with the rest of the experimental groups.

Productive, reproduction and physiological traits: The results revealed that, birds reared under NDL and 250 lux had significantly heavier body weight at 6 week and weight gain than those reared less than 500 lux and was not significant with the rest of the experimental groups (Table 2). Moreover, FI was significantly decreased in 10 lux compared to NDL group and was not

Table 1: Behavioral activities, plumage conditions and total mortality rates of quails with respect to different light intensity

	Artificial light (lux)				
Traits	10	50	250	500	Natural day light (375 lux)
Basic behavior (%)					
Standing	44.05±3.21^{ab}	41.42±3.12^{b}	51.42±3.14^{a}	40.81±2.35^{b}	51.21±2.91^{a}
Sitting	45.29±3.71^{ab}	49.11±3.78^{a}	36.26±3.52^{b}	38.57±4.01^{ab}	38.81±3.47^{ab}
Walking	10.65±1.62^{b}	9.48±1.74^{b}	12.31±1.91^{b}	20.61±2.88^{a}	10.02±2.23^{b}
Additional behavior (%)					
Preening	18.82±2.01^{ab}	12.43±1.62^{c}	16.26±1.42^{bc}	15.61±1.59^{bc}	22.81±3.53^{a}
Feeding	13.88±1.31	14.99±1.32	16.01±1.19	17.13±1.33	17.61±2.47
Drinking	5.06±0.84	4.99±0.93	4.93±0.95	5.67±0.91	4.61±1.05
Plumage conditions					
Males	5.85±0.32^{ab}	6.81±0.33^{a}	6.00±0.32^{ab}	5.37±0.33^{b}	4.66±0.34^{c}
Females	5.57±0.22^{a}	5.00±0.24^{ab}	4.93±0.22^{bc}	5.21±0.29^{a}	4.61±0.31^{c}
Overall	5.66±0.21^{a}	5.45±0.23^{a}	5.23±0.22^{a}	5.26±0.23^{a}	4.61±0.24^{b}
Total mortality (%)	11.67±4.12^{ab}	20.12±5.82^{a}	13.34±6.14^{ab}	6.67±3.35^{b}	13.33±6.15^{ab}

^{a,b}Means in any row with no common superscript differ ($p \leq 0.05$), Values are given in Mean±SE

Table 2: Productive and reproductive traits with respect to different light intensity

	Artificial light (lux)				
Items	10	50	250	500	Natural day light (375 lux)
Productive traits					
Body weight (g) at 3 weeks	109.02±2.28	108.50±2.35	111.21±2.45	110.72±2.28	110.92±2.27
Body weight (g) at 6 weeks	219.95±4.29^{ab}	215.67±4.26^{ab}	226.15±4.25^{a}	213.62±4.12^{b}	226.02±4.35^{a}
Weight gain (g) 3-6 weeks	110.92±4.58^{ab}	107.15±4.54^{ab}	114.85±4.34^{a}	102.91±4.16^{b}	115.84±4.45^{a}
Feed intake (g) 3-6 weeks	604.50±11.0^{b}	626.00±11.6^{ab}	631.50±11.0^{ab}	615.50±11.2^{ab}	647.00±11.2^{a}
Feed conversion 3-6 weeks	5.22±0.35	5.62±0.35	5.26±0.36	5.62±0.31	5.46±0.39
Egg production traits					
Age at 50% laying (d)	49.67±0.35	50.64±0.28	50.34±0.47	49.71±.38	49.35±0.57
Hen-day egg production (%)	74.51±4.51^{ab}	71.82±4.72^{b}	76.22±3.69^{ab}	84.63±4.85^{a}	80.45±2.58^{a}
Egg weight (g)	12.50±0.31	12.21±0.34	12.31±0.35	12.11±0.32	12.30±0.31
Egg mass (g hen^{-1})	847.60±77.2^{ab}	792.30±44.3^{b}	854.60±19.3^{ab}	934.80±17.3^{a}	895.80±13.1^{a}
Feed consumption (g/hen/d)	34.30±1.11^{bc}	30.24±0.59^{c}	35.25±0.34^{bc}	36.61±0.11^{b}	39.05±1.09^{a}
Feed/egg mass	3.70±0.22^{ab}	3.82±0.15^{ab}	3.81±0.12^{ab}	3.51±0.09^{b}	4.02±0.08^{a}
Reproductive traits					
Fertility (%)	89.48±1.78^{bc}	86.79±2.98^{c}	93.38±2.26^{a}	92.72±1.37^{a}	91.58±2.11^{ab}
Hatchability (%)	59.91±3.89^{b}	67.00±2.84^{a}	65.41±2.45^{a}	65.25±3.42^{a}	68.31±4.44^{a}

^{a,b}Means in any row with no common superscript differ ($p \leq 0.05$), Values are given in Mean±SE

significant with the other groups. Light intensity did not significantly affect in feed conversion ratio. However, the best feed conversion ratio was detected in birds reared at 10 lux and then 250 lux, NDL and then the rest of the groups.

In relation to egg production traits, HDEP and TEM for birds exposed to light intensity beginning of 50 lux were linearly increased with increasing light intensity. Moreover, no statistically effects were noted for light intensity at 10, 50 and 250 lux, on FI and FC during egg production period. However, birds kept at NDL and 500 lux showed the highest FI and the best FC, respectively. In this context, there were significant ($p \leq 0.05$) differences among treatments in fertility and hatchability percentage. Eggs produced from birds exposed to 250 lux had the highest fertility percentage and then 500, NDL, but the lowest values were recorded in eggs produced from birds kept at 10 and 50 lux. Moreover, hatching eggs produced from birds kept at 10 lux was significantly decreased hatchability percentage compared with those recorded from the other treatment groups.

Serum levels of T_3 and genital organs of female and male quails: Results in Table 3 show the effects of light intensity on serum levels of T_3 and genital organs of female and male quails. In relation to females, results revealed that significant differences were found among treatments in serum T_3 at different ages. At 6 week old and throughout entire the experimental period, the highest level of T_3 was found in 10 lux group, while the lowest level was recorded in 500 lux group. However, light intensity and interactions between factors did not significantly affected in relative weight and length of oviduct at 6 and 18 week old. But, significant differences were found between treatments on relative weight of ovary through entire period and the number of ovarian yellow follicle at 6 week old and throughout entire the experimental period. The highest relative weight of ovary was recorded in females subjected at NDL and then10 lux and 250 lux, while the lowest value was recorded in 500 lux group. Also, the lowest numbers of ovarian yellow follicles were recorded in females kept in 500 lux compared with other groups at 6 weeks and throughout entire the experimental period.

Table 3: Serum T_3 levels and genitalia of male and female quails at 6 and 18 week old with respect to different light intensity

Item	Age (Weak)	Artificial light (lux) 10	50	250	500	Natural day light(375 lux)	Overall
Females							
T_3 (ng mL^{-1})	6	4.57 ± 0.12^{a}	3.96 ± 0.29^{ab}	4.26 ± 0.27^{ab}	3.58 ± 0.19^{b}	3.94 ± 0.02^{ab}	4.02±0.08
	18	4.35 ± 0.04^{a}	4.17 ± 0.02^{b}	3.61 ± 0.09^{d}	3.63 ± 0.18^{d}	4.03 ± 0.11^{c}	3.95±0.09
	Overall	4.46 ± 0.07^{a}	4.06 ± 0.13^{b}	3.93 ± 0.19^{bc}	3.61 ± 0.09^{c}	3.98±0.04b	
Ovary weight (%)	6	2.31±0.83	1.02±0.98	2.54±0.89	1.02±0.87	2.33±0.82	1.85 ± 0.29^{B}
	18	2.97±0.67	2.73±0.68	2.48±0.66	2.21±0.69	3.46±0.66	2.77 ± 0.30^{A}
	Overall	2.64 ± 0.44^{ab}	1.87 ± 0.45^{ab}	2.51 ± 0.46^{ab}	1.62 ± 0.38^{b}	2.91 ± 0.41^{a}	
Oviduct weight (%)	6	3.13±0.68	1.68±0.67	2.94±0.68	1.81±0.69	2.67±0.72	2.45 ± 0.21^{B}
	18	3.41±0.48	3.46±0.45	3.33±0.38	3.58±0.39	3.33±0.32	3.42 ± 0.22^{A}
	Overall	3.27±0.34	2.57±0.34	3.13±0.38	2.69±0.39	3.00±0.34	
Oviduct length (cm)	6	26.00±4.06	21.51±4.01	30.51±4.11	21.25±4.13	27.00±4.11	25.25 ± 1.35^{B}
	18	37.25±3.30	39.75±3.25	38.87±3.45	40.12±3.35	39.71±3.34	39.14 ± 1.48^{A}
	Overall	31.62±2.30	30.62±2.25	34.68±2.45	30.68±2.35	33.35±2.34	
Ovarian yellow follicle (No)	6	5.25 ± 1.25^{a}	3.00 ± 1.26^{ab}	5.00 ± 1.21^{a}	1.51 ± 1.22^{b}	3.81 ± 1.27^{ab}	3.71±0.42
	18	4.25±0.97	4.25±0.97	4.51±0.94	3.75±0.95	5.75±0.94	4.51±0.43
	Overall	4.75 ± 0.64^{a}	3.62 ± 0.65^{ab}	4.75 ± 0.66^{a}	2.62 ± 0.66^{b}	4.77 ± 0.61^{a}	
Males							
T_3 (ng mL^{-1})	6	4.03 ± 0.05^{e}	4.11 ± 0.09^{d}	4.15 ± 0.11^{c}	4.68 ± 0.10^{a}	4.29 ± 0.01^{b}	4.25±0.07
	18	4.64 ± 0.04^{b}	4.75 ± 0.08^{a}	3.96 ± 0.10^{d}	3.79 ± 0.09^{e}	4.06 ± 0.05^{c}	4.24±0.06
	Overall	4.33±0.13	4.41±0.15	4.02±0.03	4.24±0.14	4.17±0.08	
Total testes weight (%)	6	2.50 ± 0.82^{ab}	3.00 ± 0.75^{ab}	3.51 ± 0.76^{a}	1.51 ± 0.50^{b}	2.51 ± 0.74^{ab}	2.61±0.26
	18	3.07±0.59	2.67±0.61	2.69±0.54	3.23±0.59	2.89±0.23	2.93±0.25
	Overall	2.78±0.42	2.83±0.43	3.09±0.45	2.36±0.49	2.69±0.43	
Cloacal gland (mM^2)	6	303.8 ± 23.7^{ab}	278.9 ± 21.75^{b}	303.8 ± 23.7^{ab}	309.9 ± 23.7^{ab}	351.0 ± 20.7^{a}	309.1 ± 20.3^{B}
	18	520.6 ± 35.1^{a}	506.0 ± 38.1^{ab}	505.0 ± 31.1^{ab}	421.1 ± 38.0^{b}	530.3 ± 34.0^{a}	491.2 ± 35.1^{A}
	Overall	412.3 ± 24.4^{a}	389.8 ± 20.7^{ab}	404.5 ± 19.2^{ab}	366.2 ± 21.5^{b}	450.1 ± 23.5^{a}	

[a,b]Means in any row with no common superscript differ ($p \leq 0.05$), [A,B]Means in a column and within a source with no common superscript differ ($p \leq 0.05$), Values are given in Means±SE

In relation to males, at 6 week old, the highest level of T_3 was found in 500 lux, while the lowest level was recorded in 10 lux group. Also, at 18 week old, the highest level of T_3 was found in 50 lux, while the lowest level was recorded in 500 lux group. Moreover, the highest relative weight of testes were recorded in males subjected at 250 lux thereafter 50, 10 lux and NDL, but the lowest value was recorded in males kept at 500 lux at 6 week old. Moreover, males kept at NDL had the highest cloacal gland area at 6 and 18 week old compared with the other groups, but the lowest values were recorded in males kept at 50 lux at 6 week old and 500 lux at 18 week old. In this respect, significant differences were found between two ages in most genital organs of females and males. Relative weights of ovary weight and oviduct, oviduct length and cloacal gland area were significantly higher at 18 week old than those recorded at 6 week old, irrespective to light treatments.

DISCUSSION

Light is received by the eyes and extra-retinal photoreceptors to stimulate hypothalamus area (Robinson *et al.*, 2003). In turn hormones are released by the hypothalamus that stimulates the pituitary gland. The pituitary gland produces hormones such as Follicle Stimulating Hormone (FSH) and Luteinizing Hormone (LH) that are involved with gonad development and maturation (Chen *et al.*, 2005). Day length is an important component of the poultry reproductive system. Birds are seasonal breeders and the reproductive system is stimulated by long day lengths. Much of this is Mother Nature's way of ensuring that the chicks would be reared in warmer weather to increase the probability of survival (Beebe *et al*., 2005).

The present study was designed to examine the effects of different artificial and natural day light intensities on behavioral activities, plumage conditions, productive and physiological performance of grower and layer of Japanese quail.

The results of this study found that light intensity had a strong effect on the behavioral activities traits of the Japanese quail. Birds exposed to 250 lux and NDL spent more time standing than those recorded in the other groups. Also, birds kept at 500 lux spent more time walking than those recorded in the other groups. Time of sitting was insignificantly increased in birds subjected to 10 and 50 lux compared with other groups except with 250 lux. But, NDL group spent more time preening than those recorded in other treatment groups. Moreover, the results recorded that there was a highly significant positive correlation between light intensity and percentage of walking behavior of birds. In contrast, a highly significant negative correlation was found between light intensity and percentage of sitting behavior of birds. These results are in accordance with the finding of Blatchford *et al*. (2009), who reported that light intensity had a markedly effect on the activity of the broiler chickens, birds exposed to 5 lux of light were less active during the day than those kept at 50 or 200 lux. Also, Newberry *et al*. (1988) and Kjaer and Vestergaard (1999) recorded that higher light intensity increased bird activity and consequently high energy consumption and aggressive behavior. Also, similarly with Prescott *et al*. (2003) and Downs *et al*. (2006), who recorded that low light intensity reduced activity of birds. Also, Downs *et al*. (2006), Kristensen *et al*. (2006) found that feeding behavior was not affected by the different light intensity (5, 50 and 200 lux).

In relation to plumage conditions and mortality rate, the results showed that birds kept at NDL had a significantly decreased average deterioration of plumage compared with other treatments throughout experimental period. These finding reflecting that the NDL had an adequate intensity for normal birds activities compared to low and high light intensities. Also, the lowest mortality rate was recorded in birds exposed to 500 lux and then 10, 250 and NDL. Also, our results revealed that there was a negative correlation between light intensity and plumage deterioration ($r = -0.268$) and a highly significant negative correlation with mortality rate ($r = -0.638$). Some studies have shown that low light intensity decreased physical activity resulting in more resting and sleeping of birds. Also low light intensity is thought to help reduce pecking behavior and cannibalism (Charles *et al*., 1992; Kristensen *et al*., 2006). Prescott *et al*. (2003) found that low light intensity reduced mortality due to sudden death syndrome. In contrast, other reports have observed no effect of intensity on mortality rate (Downs *et al*., 2006; Lien *et al*., 2007).

On the other hand, our results found that increasing light intensity from 10-375 lux (NDL) had no significant effect on body weight, weight gain and feed conversion ratio from 3-6 week old of growing birds. Moreover, FI increased linearly with increasing light intensity from 10-375 lux (NDL). Our results nearly with investigated by many others; Charles *et al*. (1992), Kristensen *et al*. (2006), Lien *et al*. (2008), Blatchford *et al*. (2009), Deep *et al*. (2010) and Ahmad *et al*. (2011), who reported light intensity ranged from 1-200 lux had no influence on broiler production parameters; body weight, FI and FC. However, birds exposed to 500 lux had the lowest body weight at 6 week of age and weight gain from 3-6 week of age compared with all experimental groups. These results may be returned to increase behavioral activities of birds at high light

Table 4: Correlation coefficients between light intensity treatments and some studied traits

Parameters	Light intensity
St (%)	0.199
Si (%)	-0.693**
Wa (%)	0.650**
Pr (%)	0.296
PC	-0.268
TMR	-0.638**
BW	0.018
WG	0.107
FI	0.377
FC	0.205
HDEP	0.639*
EW	-0.387
EM	0.764**
FIL	0.649**
FCE	-0.133
F (%)	0.312
H (%)	0.205
FT_3	-0.637*
OW (%)	-0.133
ODW (%)	-0.130
ODL	0.109
OYFN	-0.372
MT_3	0.247
TTW (%)	-0.401
CGA	-0.065

St: Standing, Si: Sitting, Wa: Walking, Pr: Preening, PC: Plumage conditions, TMR: Total mortality rate, BW: Body weight at 6 weak, WG: weight gain from 3-6 week, FC: Feed consumption from 3-6 week, HDEP: Hen-day egg production, EW: Egg weight, EM: Egg mass, FIL: Feed intake during laying rate, FCE: Feed conversion during egg production, F%: Fertility %, H%: Hatchability%, FT_3: Female T_3, OW: Ovary weight, ODW: Oviduct weight, ODL: Oviduct length, OYFN: Ovarian yellow follicle number, MT_3: Male T_3, TTW%: Total testes weight%, CGA: Cloacal gland area, *: ($p \leq 0.05$), **: ($p \leq 0.01$)

intensity compared with low and moderate light intensity. Correlation coefficients of our results confirmed that there were highly significant negative correlation (r = -0.693) between light intensity and time of sitting and highly significant positive correlation (r = 0.650) with time of walking behaviour (Table 4). This result similarly with Charles *et al*. (1992), who found that birds kept at dim light were decreased activity compared to other birds kept at high light intensity.

Obtained results indicated that light intensity did not statistically affected on age at 50% egg production and egg weight. These results nearly with Renema *et al*. (2001a) and Renema and Robinson (2001), who reported that sexual maturity and egg weight did not differ due to different light intensity when laying hens exposed to 1, 5, 50 or 500 lux.

Examination of ovary morphology and genital organs showed that light intensity from 10-375 did not significantly affected on overall numbers of OYF, relative weight of each ovaries and testes and cloacal gland area, but the lowest values were recorded in birds kept at 500 lux compared with the other experimental groups. Our results revealed that there were negative correlations between light intensity and each of number of OYF, relative weights of ovaries and testes and cloacal gland area (r = -0.372, -0.130, -0.401 and -0.065, respectively).

The reduction of ovary weight and quantity of OYF at high light intensity may be cleared that high light intensity play an important role in the acceleration of ovary development. This finding is in agreement with previous observations by Renema and Robinson (2001) and Renema *et al*. (2001b), who recorded that birds subjected at high light intensity (500 lux) had reaped ovary development and accelerate reproductive senescence of laying hen than their low light intensity. Moreover, HDEP and TEM for birds exposed to light intensity beginning to 50 lux were increased with increasing light intensity. Also, significant positive correlations were recorded between light intensity and each of HDEP and TEM (r = 0.639 and 0.764, respectively). These results are in accordance with the finding of Renema *et al*. (2001b), who recorded that HDEP between 21-37 weeks of age of laying hens increased with increasing light intensity from 1-500 lux. Also, similarly with Abdelkarim and Biellier (1982), who found that HDEP was increased in hens kept at high intensity from 343-408 lux compared to hens kept at lower intensity.

In this respect, the results revealed that no significant effect of light intensity of 10, 50 and 250 lux on FI and FC during egg production period. However, the highest FI was recorded in birds kept at NDL. But, the best FC was recorded in birds kept at 500 lux. Moreover, a highly significant positive correlation (r = 0.649) and a negative correlation (r = 0.133) were estimated between light intensity and each of FI and FC, respectively. These findings are in agreement with previous observation by Siopes (1991), who reported that no differences in FI or FC in a turkey hen using light intensity between 54 and 324 lux. But does not agree with Lewis and Morris (1999), who predicted through regression analysis of six studies performed between 1946 and 1993, that daily FI of production hens decreases linearly by 0.2 g for each 10 lux increase in light intensity to 100 lux. They attributed differences in FI to egg production rate. However, the results indicated that fertility and hatchability percentages were reduced under low light intensity (10 and 50 lux) compared with the other experimental groups. In this context, our results found that there was a positive correlation between light intensity and fertility and hatchability percentage (0.312 and 0.205, respectively).

Adequate light intensity is required to stimulate the hypothalamus area through the eyes and extra-retinal photoreceptors (Robinson *et al*., 2003). Consequently hypothalamus will release GnRH. These hormones stimulate the anterior pituitary to release LH and FSH. In males, LH controls the production of the major sex steroid hormone (testosterone), which secreted by Leydig cells in the testes. In females, the secretion of LH and FSH control the secretion of estrogen, which necessary for yolk precursor lipoprotein secretion by the liver and oviduct and ovarian follicles development (Mayes and Watson, 2004; Chen *et al*., 2005). Dim light may not be able to penetrate the skull and may be unable or less likely to excite receptors to release GnRH (Morgan *et al*., 1995). Which due to decreased testicular size in birds (Siopes *et al*., 1983) and reduction blood level of FSH (Lewis *et al*., 2005). Also, light stimulate increase secretion of metabolic hormones (T_3, T_4, insulin, GH and IGF-1). All these hormones shared in development and enhancing productive and reproductive functions of domestic birds (Boon *et al*., 2000; Mateescu and Thonney, 2005). Our results showed that serum levels of T_3 decreased linearly with increasing light intensity throughout entire the experimental period in females and at 18 week old in males. The highest value was detected in birds kept at 10 lux, but the lowest value was detected in kept at 500 lux. The opposite result was recorded in serum of males at 6 week old, the highest level of T_3 was found in 500 lux, while the lowest level was recorded in 10 lux group. These results confirmed the role of light intensity to stimulate of thyroid gland to release thyroid hormones. On the other hand, results revealed that there was a significant negative correlations between light intensity and concentration of female serum T_3 (r = -0.637) and a significant positive correlations with HDEP (r = 0.639). These reductions in serum T_3 level in high light intensity may be returned to shift T_3 from the blood to the important tissues of the body such as; liver, oviduct and gastrointestinal tract. Our results attributed differences in T_3 levels to increase egg production rate and to increase activity of birds under moderate and high light intensity.

Moreover, many researchers reported that lighting plays an important role in regulation of the function of the hypothalamus-pituitary-thyroid axis, the hypothalamus area secrete TSH which stimulate and release of thyroid hormones (Wittkowski *et al*., 1988). Thyroid hormones especially T_3 have a multiple effects on vertebrate metabolism and development. A T_3 regulate basal metabolic rate and are essential for the maintenance and constant body temperature and protein and lipid metabolism (Collin *et al*., 2005; Lu *et al*., 2007). Also during development, T_3 stimulate both growth and differentiation of organs, their action can be direct, indirect or permissive (Zation *et al*., 1993). Also, T_3 acts together with insulin to elevate the rate of lipogenesis in chicken hepatocytes *in vitro* (Wilson *et al*., 1986). A T_3 increases glucose active transport through the small intestine (Black, 1988). In addition, T_3 activates GH synthesis and synergistically stimulate GH expression with glucocorticoids (Yaffe and Samuels, 1984).

CONCLUSION

In conclusion, current results indicated that the majority of the correlations coefficients among light intensity and studied traits were low to moderate especially during growing period (BW, FI and FC), but the minority were moderate to high especially during laying period (F%, H%, HDEP and TEM). Also, the results noticed that using artificial moderate light intensity and natural day light intensity were superior in most studied traits compared to low and high light intensity. Therefore, to maximize productive, reproductive parameters and increase revenue economic may be by using moderate light intensity if we used closed side housing system or NDL if we used open side housing system for production of Japanese quail.

REFERENCES

Abdelkarim, M.R. and H.V. Biellier, 1982. Effect of light intensity and photoperiod on chicken laying hens. Poult. Sci., 61: 1403-1404.

Ahmad, F., A.U. Haq, M. Ashraf, G. Abbas and M.Z. Siddiqui, 2011. Effect of different light intensities on the production performance of broiler chickens. Pak. Vet. J., 31: 203-206.

Alvino, G.M., R.A. Blatchford, G.S. Archer and J.A. Mench, 2009. Light intensity during rearing affects the behavioural synchrony and resting patterns of broiler chickens. Br. Poult. Sci., 50: 275-283.

Beebe, K., G. E. Bentley and M. Hau, 2005. A seasonally breeding tropical bird lacks absolute photorefractoriness in the wild, despite high photoperiodic sensitivity. Functional Ecol., 19: 505-512.

Black, B.L., 1988. Development of glucose active transport in embryonic chick intestine. Influence of thyroxine and hydrocortisone. Comp. Biochem. Physiol. Part A: Physiol., 90: 379-386.

Blatchford, R.A., K.C. Klasing, H.L. Shivaprasad, P.S. Wakenell, G.S. Archer and J.A. Mench, 2009. The effect of light intensity on the behavior, eye and leg health and immune function of broiler chickens. Poult. Sci., 88: 20-28.

Boon, P.G., G.H. Visser and S. Daan, 2000. Effect of photoperiod on body weight gain, and daily energy intake and energy expenditure in Japanese quail (*Coturnix c. Japonica*). Physiol. Behav., 70: 249-260.

Charles, R.G., F.E. Robinson, R.T. Hardin, M.W. Yu, J. Feddes and H.L. Classen, 1992. Growth, body composition and plasma androgen concentration of male broiler chickens subjected to different regimens of photoperiod and light intensity. Poult. Sci., 71: 1595-1605.

Chen, K.L., W.T. Chi and P.W.S. Chiou, 2005. Caponization and testosterone implantation effects on blood lipid and lipoprotein profile in male chickens. Poult. Sci., 84: 547-552.

Collin, A., S. Cassy, J. Buyse, E. Decuypere and M. Damon, 2005. Potential involvement of mammalian and avian uncoupling proteins in the thermogenic effect of thyroid hormones. Domest. Anim. Endocrinol., 29: 78-87.

Dawson, A., 2005. Seasonal differences in the secretion of luteinising hormone and prolactin in response to *N*-methyl-DL-aspartate in starlings (*Sturnus vulgaris*). J. Neuroendocrinol., 17: 105-110.

Deep, A., K. Schwean-Lardner, T.G. Crowe, B.I. Fancher and H.L. Classen, 2010. Effect of light intensity on broiler production, processing characteristics and welfare. Poult. Sci., 89: 2326-2333.

Downs, K.M., R.J. Lien, J.B. Hess, S.F. Bilgili and W.A. Dozier III, 2006. The effects of photoperiod length, light intensity and feed energy on growth responses and meat yield of broilers. J. Applied Poult. Res., 15: 406-416.

Duncan, D.B., 1955. Multiple range and multiple *F* tests. Biometrics, 11: 1-42.

Hill, J.A., D.R. Charles, H.H. Spechter, R.A. Bailey and A.J. Ballantyne, 1988. Effects of multiple environmental and nutritional factors in laying hens. Br. Poult. Sci., 29: 499-511.

Khalil, H.A., 2009. Productive and physiological responses of Japanese quail embryos to light regime during incubation period. Slovak J. Anim. Sci., 42: 79-86.

Khalil, H.A., M.E. Mady, A.M. Hassanein and M.Gerken, 2012. Effects of different environmental temperatures during the rearing phase on behaviour traits in Japanese quail. Proceedings of the 3rd Mediterranean Summit of WPSA & 6th International Poultry, March 26-29, 2012, World Poultry Science Association, pp: 315-321.

Kjaer, J.B. and K.S. Vestergaard, 1999. Development of feather pecking in relation to light intensity. Applied Anim. Behav. Sci., 62: 243-254.

Kristensen, H.H., G.C. Perry, N.B. Prescott, J. Ladewig, A.K. Ersboll and C.M. Wathes, 2006. Leg health and performance of broiler chickens reared in different light environments. Br. Poult. Sci., 47: 257-263.

Lewis, P.D. and T.R. Morris, 1998. Responses of domestic poultry to various light sources. World's Poult. Sci. J., 54: 7-25.

Lewis, P.D. and T.R. Morris, 1999. Light intensity and performance of domestic pullets. World's Poult. Sci. J., 55: 241-250.

Lewis, P.D., P.J. Sharp, P.W. Wilson and S. Leeson, 2004. Changes in light intensity can influence age at sexual maturity in domestic pullets. Br. Poult. Sci., 45: 123-132.

Lewis, P.D., N. Ciccone, P.W. Wilson and S. Leeson, 2005. Light intensity can influence plasma FSH and age at sexual maturity in domestic pullets. Br. Poult. Sci., 46: 506-509.

Lewis, P. and T. Morris, 2006. Physiology and Mechanisms, In: Poultry Lighting the Theory and Practices Lewis, P. and T. Morris (Eds.)., Northcot andover, UK, pp: 7-22.

Lien, R.J., J.B. Hess, S.R. McKee, S.F. Bilgili and J.C. Townsend, 2007. Effect of light intensity and photoperiod on live performance, heterophil-to-lymphocyte ratio and processing yields of broilers. Poult. Sci., 86: 1287-1293.

Lien, R.J., J.B. Hess, S.R. McKee and S.F. Bilgili, 2008. Effect of light intensity on live performance and processing characteristics of broilers. Poult. Sci., 87: 853-857.

Lu, J.W., J.P. McMurtry and C.N. Coon, 2007. Developmental changes of plasma insulin, glucagon, insulin-like growth factors, thyroid hormones and glucose concentrations in chick embryos and hatched chicks. Poult. Sci., 86: 673-683.

Mateescu, R.G. and M.L. Thonney, 2005. Effect of testosterone on insulin-like growth factor-I, androgen receptor and myostatin gene expression in splenius and semitendinosus muscles in sheep. J. Anim. Sci., 83: 803-809.

Mayes, J.S. and G.H. Watson, 2004. Direct effects of sex steroid hormones on adipose tissues and obesity. Obesity Rev., 5: 197-216.

Mekawy, I.A., 2014. The effect of altering behaviour on productive and physiological traits in Japanese quail. M.Sc., Thesis, Fac. Agric., Suez Canal Univ., Ismalia, Egypt.

Morgan, I.G., M.K. Boelen and P. Miethke, 1995. Parallel suppression of retinal and pineal melatonin synthesis by retinally mediated light. Neuroreport, 6: 1530-1532.

NRC., 1994. Nutrient Requirements of Poultry. 9th Rev. Edn., National Academy Press, Washington, DC., USA., ISBN-13: 978-0309048927, Pages: 176.

Newberry, R.C., J.R. Hunt and E.E. Gardiner, 1988. Influence of light intensity on behavior and performance of broiler chickens. Poult. Sci., 67: 1020-1025.

Prescott, N.B., C.M. Wathes and J.R. Jarvis, 2003. Light, vision and the welfare of poultry. Anim. Welfare, 12: 269-288.

Prescott, N.B., H.H. Kristensen and C.M. Wathes, 2004. Light, In: Measuring and Auditing Broiler Welfare. Weeks, C. and A. Butterworth (Eds.)., CAB Int., Wallingford, UK, pp: 101-116.

Renema, R.A. and F.E. Robinson, 2001. Effects of light intensity from photostimulation in four strains of commercial egg layers: 1. Ovarian morphology and carcass parameters. Poult. Sci., 80: 1112-1120.

Renema, R.A., F.E. Robinson, H.H. Oosterhoff, J.J. Feddes and J.L. Wilson, 2001a. Effects of photostimulatory light intensity on ovarian morphology and carcass traits at sexual maturity in modern and antique egg-type pullets. Poult. Sci., 80: 47-56.

Renema, R.A., F.E. Robinson, J.J. Feddes, G.M. Fasenko and M.J. Zuidhoft, 2001b. Effects of light intensity from photostimulation in four strains of commercial egg layers: 2. Egg production parameters. Poult. Sci., 80: 1121-1131.

Robinson, F., G.M. Fasenko and R.A. Renema, 2003. Optimizing Chick Production in Broiler Breeders. Spotted Cow Press, Edmonton, ISBN: 9780973101218, Pages: 132.

SAS., 2001. SAS User's Guide: Statistics. SAS Institute, Carry, USA.

Siopes, T.D., M.B. Timmons, G.R. Baughman and C.R. Parkhurst, 1983. The effect of light intensity on the growth performance of male turkeys. Poult. Sci., 62: 2336-2342.

Siopes, T.D., 1991. Light intensity effects on reproductive performance of turkey breeder hens. Poult. Sci., 70: 2049-2054.

Wilson, S.B., D.W. Back, S.M. Morris Jr., J. Swierczynski and A.G. Goodridge, 1986. Hormonal regulation of lipogenic enzymes in chick embryo hepatocytes in culture. Expression of the fatty acid synthase gene is regulated at both translational and pretranslational steps. J. Biol. Chem., 261: 15179-15182.

Wittkowski, W., M. Bergmann, K. Hoffmann and F. Pera, 1988. Photoperiod-dependent changes in TSH-like immunoreactivity of cells in the hypophysial pars tuberalis of the Djungarian hamster, *Phodopus sungorus*. Cell Tissue Res., 251: 183-187.

Yaffe, B.M. and H.H. Samuels, 1984. Hormonal regulation of the growth hormone gene. Relationship of the rate of transcription to the level of nuclear thyroid hormone-receptor complexes. J. Biol. Chem., 259: 6284-6291.

Yahav, S., S. Hurwitz and I. Rozenboim, 2000. The effect of light intensity on growth and development of turkey toms. Br. Poult. Sci., 41: 101-106.

Zation, Z., Z. Merican, B.A.K. Khalil, J.B. Mohamed and S. Baharom, 1993. The effects of propranolol on skeletal muscle contraction, lipid peroxidation products and antioxidant activity in experimental hyperthyroidism. Gen. Pharmacol: Vasc. Syt., 24: 195-199.