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PRODUCTIVE AND PHYSIOLOGICAL RESPONSES OF JAPANESE QUAIL EMBRYOS TO LIGHT REGIME DURING INCUBATION PERIOD

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ABSTRACT

This study was conducted to investigate the effect of light regime during egg incubation of Japanese quail embryos on growth during embryonic life, hatchability percentage, chick performance post-hatch life, embryo plasma thyroid hormone concentrations and some metabolic parameters. A total of 1400 hatching eggs of Japanese quail were collected at 10thand 14th weeks of age. Eggs were divided into two groups, the first group was set in incubator at dark, and the second group was set at light. White florescent light was used (20 watt) during the incubation period. The light intensity ranged from 620-835 *lux* at the surface of the fertile eggs. Results showed highly significant differences ($P \leq 0.001$) between both incubated groups on most of the studied traits. Relative embryonic weight and hatchability percentage were significantly higher in the light group by 2.05% and 5.63%, respectively than that in the dark group. Chicks hatched under light regime were significantly ($P \leq 0.05$) heavier in body weight (one-day old & 6 week old) and weight gain (0-6 weeks) than those hatched under dark regime. The best feed conversion was found for chicks hatched under light regime compared with those hatched under dark regime (3.78 *vs.* 4.43). Furthermore, light incubation group showed higher ($P \leq 0.0001$) plasma triiodothyronine hormone (T_3) level and T_3/T_4 ratio, plasma total protein, albumen, globulin, glucose, cholesterol, triglycerides and total lipids concentrations than those found in the dark incubation group. It was concluded that exposure to light during incubation period increased hatchability percentage and improved growth performance during embryonic life and post-hatch life by enhancing the physiological-metabolic processes.

Keywords: japanese quail; light regime; T_3, T_4, hatchability; growth performance

INTRODUCTION

Various factors play important roles in influencing hatchability efficiency and growth performance during embryonic and post-hatch life, such as genetic, egg characteristics and incubation environment (Christensen, 1995; Nestor and Noble, 1995; Narushin and Romanov, 2002; Petek et al*.,* 2003; Abiola et al., 2008). Light is one of the environmental factors that improves embryonic growth and hatchability performance of avian eggs (Fairchild and Christensen, 2000; Shafey and Al-Mohsen, 2002). Cooper (1972) stated that poults hatched from eggs exposed to fluorescent lights appeared to be more active than poults incubated and hatched in dark. Light-induced acceleration of embryonic development *in ovo* depends on the amount of light that reaches the embryo (Ghatpande et al*.,* 1995). The light incubation accelerates hatching time compared to dark incubations in meat breeder eggs (Al-Mohsen and Shafey, 2004). Shafey (2004) found that light incubation increased daily embryonic growth (mg/d) and hatchability percentage by 3.90 and 5.90%, respectively of layer breeder eggs when compared with the dark incubation.

However, some disagreement in the literature was reported regarding the effect of light incubation on hatchability performance and physiological responses during incubation and post-hatching. Isakson et al. (1970) reported negative effect of light on glucose metabolism

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in light-treated compared with dark-treated embryos. Bowling et al. (1981) found that light exposure during incubation reduced hatchability percentage of White Leghorn eggs. Zakaria (1989) reported no improvement in hatchability percentage of meat-type breeder eggs incubated under light.

On the other hand, many studies have focused on the effect of light incubation on acceleration of hatching time and hatchability percentage, but few workers have studied the hormonal and metabolic changes of embryos and performance of chicks after hatch. The aims of the present study were to evaluate (i) the influence of light regime during incubation period on embryonic growth and hatchability percentage, (ii) some physiological characters in embryos incubated in light and (iii) the influence of light incubation on performance of chicks after hatch.

MATERIAL AND METHODS

The experimental work was carried out at the Poultry Farm, Department of Animal Production, Faculty of Agriculture, Suez Canal University, Ismailia, Egypt. A total of 1400 fertile eggs produced by Japanese quail hens were used in this study. Two force-draft incubators were used for incubation of eggs. Eggs were numbered and weighed individually and randomly divided into two groups. The first group was set in incubator at dark, while the second was set at light. White florescent light was used (one-tube, 20 watt) during the incubation period. The light intensity ranged from 620-835 *lux* at the surface of the fertile eggs as measured with a luxmeter. All eggs were incubated under the same conditions of ambient temperature (37.5°C) and relative humidity (60%) in both incubators. Eggs were turned every 2-hr, and they were transferred to hatcher on day 14 of incubation under the same incubator condition of light regime. From day 14 to complete hatching the temperature and relative humidity were 37°C and 65%, respectively. Two incubation trials were done at 10 and 14 weeks of hen's age. The second trial was devoted completely to study of embryonic growth, blood metabolism, hormonal assay and chick's performance after hatch.

Studied Traits

1. Embryonic growth and development

In the second trial, 120 eggs per treatment were removed for determination of weight of embryos and giblets (liver, heart and gizzard) on day 12 and day 16 of incubation. Eggs were broken open and embryos were separated and weighed individually after removing the yolk sac and wrapped thoroughly with tissue paper. Absolute and relative weights of embryos and giblets were calculated.

2. Hatchability and embryonic mortality

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 1st group was early dead embryos (EDE) from 1-5 days, the 2nd group was late dead embryos (LDE) from 6-15 days, the 3rd 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). Fertility was estimated as percentage of fertile eggs to total number of eggs set. Hatchability was calculated as the percentage of total hatched chicks to the number of fertile eggs.

3. Plasma hormonal assay and biochemical parameters of embryos

One hundred blood samples were collected from embryos kept in dark or light incubation (50 in each) at 12 and 16 days of incubation (25 in each) in heparinized tubes. Blood samples were centrifuged at 3000 rpm for 15 min. and plasma was stored at -20°C for further analysis. Plasma T_3 and T_4 concentrations (ng/dl) were determined by enzymatic immunoassay (ELIZA) kits (BioCheck, Inc. Foster City, USA). Plasma total protein, albumen, glucose, total lipids, cholesterol and triglycerides were determined calorimetrically by using available commercial kits from Egyptian Company for Biotechnology (S.A.E., Cairo). The globulin values were calculated by subtracting the values of albumen from the corresponding values of total protein.

4. Performance after hatching

One hundred and eighty unsexed one-day-old quail chicks from both dark and light treatments were used to evaluate the chicks performance after hatching. Ninety chicks from every treatment were individually weighed and randomly distributed into three replicates (30 chicks each). The chicks were kept under normal brooding conditions in batteriescages (100x50x50cm) throughout the experimental period (6 weeks). Both food and water were provided *ad-libitum*. The ration contained 24% CP and 3000 Kcl(ME)/kg. Individual live body weights and feed intake were recorded weekly until 6 weeks of age, in addition, body weight gain and feed conversion were calculated during the same periods.

Statistical Analyses

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) among means were tested.

Tab. 1: Absolute and relative weight of embryos at day 12 and day 16 of incubation as affected by dark and light regimes

Main effect		No.	Egg weight (g)	Embryo weight		(Liver-Heart-Gizzard) weights	
				(g)	(%)	(g)	(%)
Incubation status (I)							
	Dark	92	10.01±0.11	5.10±0.06	56.62±0.31^{b}	0.48±0.01^{b}	8.42±0.13^{b}
	Light	94	9.91±0.10	5.25±0.05	57.78±0.30^{a}	0.53±0.01^{a}	9.13±0.12^{a}
	P.Value		0.5157	0.0850	0.0091	0.0011	0.0001
Day of incubation (D)							
	12	107	11.83±0.08^{a}	3.57±0.04^{b}	30.39±0.23^{b}	0.18±0.01^{b}	5.17±0.01^{b}
	16	79	8.07±0.09^{b}	6.77±0.05^{a}	84.01±0.28^{a}	0.83±0.02^{a}	12.36±0.11^{a}
	P.Value		0.0001	0.0001	0.0001	0.0001	0.0001
Interaction effect (I x D)							
Dark	12	52	11.92±0.14^{a}	3.34±0.07^{c}	28.12±0.41^{d}	0.16±0.01^{d}	5.01±0.17^{c}
	16	40	8.08±0.16^{b}	6.86±0.08^{a}	85.11±0.47^{a}	0.81±0.02^{b}	11.81±0.19^{b}
Light	12	55	11.74±0.13^{a}	3.82±0.05^{b}	32.61±0.38^{c}	0.21±0.01^{c}	5.35±0.16^{c}
	16	39	8.06±0.16^{b}	6.68±0.06^{a}	82.91±0.42^{b}	0.85±0.02^{a}	12.91±0.19^{a}
	P.Value		0.6166	0.0001	0.0001	0.0412	0.0500

^{a,b,c,d}Means within column not sharing a common superscript differ significantly (P≤ 0.05)

RESULTS

1. Embryonic Growth and Development

The effects of incubation status and day of incubation on embryonic growth and development are presented in Table 1. Light incubation increased (P≤0.01) relative embryo body weight and absolute and relative giblets weights (liver, heart and gizzard) compared with dark incubation. With advancing days of incubation, absolute and relative weight of embryos and giblets were higher (P≤0.0001) at day 16 than day 12 of incubation. There were significant (P≤0.0001) interaction between incubation status and day of incubation on embryonic growth. Embryos kept in dark had the heaviest absolute and relative weight at day 16 of incubation, but the lightest values were obtained in the same treatment at day 12 of incubation. On the other hand, embryos kept in light incubation and day 16 of incubation had the heaviest absolute and relative giblets weights, but the lightest values were found in dark group at day 12 of incubation.

2. Hatchability Percentage and Embryonic Mortality

Results in Table 2 showed that treatments had a significant effect on hatchability percentage and embryonic mortality. Eggs incubated under light regime had superior (P≤0.001) hatchability percentage (HP) and lower (P≤0.05) late dead embryos (LDE), dead in shell (DIS) and pipped dead embryos (PDE) percentage than those incubated under dark. Eggs obtained at older age in trial 2 had higher HP and EDE (*P≤0.041*), and lower LDE and PDE (P≤0.05) than eggs used in trial 1. There was a significant interaction between incubation treatment and trials on hatchability and embryonic mortality. Eggs incubated under light and trial 2 had the highest value of HP and the lowest values of LDE, DIS and PDE.

3. Chicks Performance after Hatch

Body weights, weight gain, feed intake, feed conversion and mortality rate from hatching to 6-week-old of quail chicks as affected by incubation treatment are shown in Table 3. Results revealed that chicks produced from light incubation were heavier (P≤0.05) in body weight at one-day-old and 6-week of age (P≤0.0001) and higher weight gain (P≤0.0001) from hatch to 6 weeks of age than those produced form dark incubation. The best results of feed conversion were realized from chicks hatched under light incubation (P≤0.05) compared with those hatched under dark incubation during 0-6 weeks of age. Treatments had no significant effects on feed intake and mortality rate through 0-6 weeks of age.

4. Biochemical Parameters of Quail Embryos at Day 12 and Day 16 of Incubation

Plasma total protein, albumen and globulin

Results in Table 4 indicated that light incubation resulted in a significant (P≤0.0001) increase of plasma total protein, albumen and globulin by 27, 50 and 18%, respectively compared to dark incubation. There was

Tab. 2: Hatchability percentage and embryonic mortality rate of quail eggs incubated at dark and light regimes

Main effect		No.	HP [1]	EDE (%)	LDE (%)	DIS (%)	PDE (%)
Incubation status (I)							
	Dark	580	74.02±1.1^{b}	4.97±0.5	16.14±0.7^{a}	3.64±0.4^{a}	1.23±0.2^{a}
	Light	580	78.19±1.2^{a}	5.02±0.4	13.76±0.6^{b}	2.31±0.4^{b}	0.73±0.2^{b}
	P.Value		0.0011	0.0654	0.0421	0.0261	0.0041
Trial (T) [2]							
	1	700	75.15±1.1^{b}	4.51±0.4^{b}	15.96±1.5^{a}	2.55±0.5	1.14±0.1^{a}
	2	460	77.02±1.2^{a}	5.52±0.3^{a}	14.61±0.8^{b}	2.68±0.5	0.84±0.2^{b}
	P.Value		0.0394	0.0411	0.04541	0.1223	0.03121
Interaction effect (IxT)							
Dark	1	350	73.08±1.1^{d}	4.89±0.5	17.35±1.2^{a}	2.98±0.4^{b}	1.48±0.2^{a}
	2	230	75.12±1.2^{c}	4.97±0.4	15.15±1.1^{b}	4.26±0.4^{a}	1.00±0.1^{b}
Light	1	350	76.48±1.1^{b}	4.68±0.6	15.05±1.2^{b}	2.46±0.3^{bc}	1.08±0.3^{b}
	2	230	79.78±1.2^{a}	4.86±0.4	13.95±1.1^{c}	2.15±0.6^{c}	0.41±0.4^{c}
	P.Value		0.0011	0.0514	0.0024	0.0015	0.0021

^{a,b} Means within column not sharing a common superscript differ significantly (P≤ 0.05).

[1] HP= Hatchability percentage from fertile eggs, fertility percentage of eggs were 91.28±1.45 and 92.37±1.12 for dark and light regimes, respectively (*P=0.6124*); 90.56 and 93.74 for trials 1 and 2, respectively (*P=0.0001*).

[2] Eggs obtained from quails at the age of 10 and 14 weeks for trials 1 and 2, respectively

Tab. 3: Body weight, weight gain, feed intake and conversion from hatch to 6-week-old chicks hatched under dark and light regime

Treatment	No.	Body weight (g)		Weight gain (g)	Feed intake (g/b)	(gm feed/ gm gain)	Mortality (0-6 weeks)
		One-day-old	6-week-old				
Dark	90	7.85±0.12^{b}	214.15±13.64^{b}	206.31±11.18^{b}	915.51±25.57	4.43±0.26^{b}	5.45±0.26
Light	90	8.94±0.14^{a}	246.98±13.29^{a}	238.04±12.24^{a}	902.76±12.24	3.78±0.31^{a}	4.06±0.24
P.Value		0.0342	0.0001	0.0001	0.1234	0.0414	0.0942

^{a,b,c,d}Means within column not sharing a common superscript differ significantly (P≤ 0.05)

a significant (P≤0.0001) increase in total protein and globulin at day 12 of incubation, however, albumen increased at day 16 of incubation. The interaction between incubation treatment and age of embryo had a significant (P≤0.0001) effect on these traits. The highest values of total protein, albumen and globulin were found in light group at day 12 of incubation, but the lowest values were obtained in dark incubator and day 12 of incubation for total protein and albumen, but the lowest globulin value was found in light group at day 12 of incubation.

Plasma glucose concentration

Results in Table 4 showed that embryos kept in light incubation had a significant (P≤0.0001) increase in plasma glucose concentration by 83% in comparison with those kept in dark incubation. With the progress of day of incubation, embryos at day 16 increased their plasma glucose by 193% compared to day 12 of incubation. Also, plasma glucose concentration was significantly affected by the interaction between incubation status and day of incubation. The highest level was found in the light group at day 16 of incubation, but the lowest level was in the dark group at day 12 of incubation.

Plasma total lipids, cholesterol and triglycerides

Plasma total lipids, cholesterol and triglycerides of embryos differed significantly (P≤0.0001) under different treatments (Table 4). Embryos kept in the light incubation showed significant (P≤0.0001) increases in plasma total lipids, cholesterol and triglycerides concentration by 29, 28 and 55%, respectively compared to those kept in the dark incubation. With the progress of day of incubation,

Tab. 4: Plasma biochemical constituents of embryos at day 12 and day 16 of incubation as affected by dark and light regimes

Main effect		No.	Total protein (g/dl)	Albumen (g/dl)	Globulin (g/dl)	Glucose (mg/dl)	Total lipids (mg/dl)	Cholesterol (mg/dl)	Triglycerides (mg/dl)
Incubation status (I)									
	Dark	50	2.33± 0.1^{b}	0.68±0.1^{b}	1.65±0.1^{b}	77.51±1.2^{b}	521.37±12.3^{b}	163.22±7.2^{b}	212.54±14.0^{b}
	Light	50	2.97±0.1^{a}	1.02±0.2^{a}	1.95±0.2^{a}	141.75±1.3^{a}	671.42±13.5^{a}	208.74±8.4^{a}	328.71±15.4^{a}
	P.Value		0.0002	0.0001	0.0121	0.0001	0.0001	0.0001	0.0001
Day of incubation (D)									
	12	50	2.86±0.1^{a}	0.79±0.1^{b}	2.07±0.1^{a}	55.87±0.81^{b}	486.12±12.4^{b}	79.25± 4.8^{b}	247.52±9.2^{b}
	16	50	2.45±0.1^{b}	0.91±0.2^{a}	1.53±0.1^{b}	163.38±1.21^{a}	706.07±13.6^{a}	292.72±8.4^{a}	293.73± 3.2^{a}
	P.Value		0.0146	0.0001	0.0019	0.0001	0.0001	0.0001	0.0391
Interaction effect (IxD)									
Dark	12	25	1.93±0.1^{c}	0.53±0.2^{c}	1.39±0.2^{c}	48.62±1.4^{d}	410.56±12.4^{d}	51.81±8.7^{d}	153.13±16.4^{c}
	16	25	2.73±0.2^{b}	0.83±0.3^{b}	1.91±0.1^{b}	106.38±2.0^{b}	631.76±11.7^{b}	274.64±12.0^{b}	271.95±23.2^{b}
Light	12	25	3.78±0.1^{a}	1.04±0.1^{a}	2.74±0.1^{a}	63.11±1.3^{c}	561.68±10.9^{c}	106.71±7.9^{c}	341.91±15.2^{a}
	16	25	2.16±0.2^{c}	1.00±0.1^{a}	1.15±0.2^{c}	220.39±2.0^{a}	780.39±12.4^{a}	310.80±12.0^{a}	315.51±23.0^{a}
	P.Value		0.0001	0.0001	0.0001	0.0001	0.0452	0.0312	0.0014

^{a,b,c,d} Means within column not sharing a common superscript differ significantly (P≤ 0.05)

Tab. 5: Plasma T_3 and T_4 concentrations of embryos at day 12 and day 16 of incubation as affected by dark and light regimes

Main effect		No	T_3 (ng/dl)	T_4 (ng/dl)	T_3/T_4
Incubation status (I)					
	Dark	50	260.16±5.25^{b}	693.75±15.64	0.37±0.01^{b}
	Light	50	375.52±7.16^{a}	687.69±14.62	0.54±0.02^{a}
	P.Value		0.0001	0.0631	0.0001
Day of incubation (D)					
	12	50	308.12±6.33^{b}	695.37±16.64	0.44±0.02^{b}
	16	50	326.35±8.64^{a}	686.19±14.19	0.48±0.02^{a}
	P.Value		0.0001	0.0655	0.0011
Interaction effect (IxD)					
Dark	12	25	290.37±6.23^{c}	698.19±14.97	0.41±0.02^{c}
	16	25	227.81±5.14^{d}	689.42±15.97	0.33±0.01^{d}
Light	12	25	325.19±7.34^{b}	692.54±14.12	0.47±0.03^{b}
	16	25	425.39±8.34^{a}	682.94±13.97	0.62±0.02^{a}
	P.Value		0.0001	0.0666	0.0061

^{,b,c,d} Means within column not sharing a common superscript differ significantly (P≤ 0.05)

embryos at day 16 had increased plasma total lipids, cholesterol and triglycerides compared to day 12 of incubation. There was a significant (P≤0.0001) interaction between incubation status and day of incubation on plasma total lipids, cholesterol and triglycerides concentration. Embryos of the light group at day 16 of incubation had the highest values, but dark group at day 12 of incubation had the lowest values.

5. Plasma T_3 and T_4 Assay of Quail Embryos at 12 and 16 Days of Incubation

Table 5 showed highly significant (P≤0.0001) differences between treatments and day of incubation on plasma T_3 level and T_3/T_4 ratio. Plasma T_3 concentration and T_3/T_4 ratio increased when embryos kept at light incubation by 44 and 46%, respectively compared with those kept at dark incubation. Day of incubation increased (P≤0.0001) the level of T_3 and T_3/T_4 ratio. On the other hand, plasma T_3 level and T_3/T_4 ratio were significantly affected by the interaction between incubation status and day of incubation. The highest level of T_3 and T_3/T_4 ratio were obtained in the light group at day 16 of incubation, but the lowest values were obtained in the dark group at day 12

of incubation. The main effect of treatments and day of incubation and their interaction had no significant effect on plasma T_4 concentration.

DISCUSSION

Results from the present study clearly showed that incubation under light regime influenced differently the embryonic growth, hatchability percentage and chicks performance after hatch. Light regime incubation improved significantly the embryonic growth, hatchability percentage and chicks performance after hatching when compared with the dark incubation. These results are in agreement with other reports (Cooper, 1972; Ghatpande et al., 1995; Shafey and Al-Mohsen, 2002; Shafey, 2004) who found that light regime incubation enhanced chicken embryonic growth and hatchability percentage, and also the chicks hatched under light regime incubation appeared to be more active when compared with those hatched under dark incubation. These improvements mainly related to physiological and metabolic responses to light during embryonic development. Avian embryos tend to float to the top of the yolk to a position just under the egg shell, where they are exposed to the light penetrating through the egg shell. The amount of light reaching the developing embryos triggers the stimulatory effect and consequently the amount of growth acceleration (Ghatpande et al., 1995). Results showed clear physiological and metabolic responses to light via activation of thyroid gland and increase biochemical constituents in blood plasma of developing embryos (Table 4 & 5).

Plasma T_3 concentration (Table 5) increased in embryos kept in light regime incubation by 44% compared with those kept at dark incubation, this increment indicates a hyperthyroid activity under light regime. Many researchers reported that light plays an important role in the development and growth of birds by the regulation of the function of the hypothalamus-pituitary-thyroid axis via eyes and extra-retinal photoreceptors, the hypothalamus area secrete TSH which cause production and secretion of thyroid hormones (Ottenweller and Hedge,1982; Jerry, 1984; Wittkowski et al.,1988). Serum TSH, T_3 and T_4 concentrations increased significantly during the light period of the daily cycle and decreased during the dark period of the cycle in rats (Ottenweller and Hedge, 1982; Jerry, 1984; Laakso et al., 1990).

These results are in a good agreement with Decuypere et al. (2005) who stated that high thyroid hormone concentrations during embryonic development appear to be stimulating a variety of developmental and metabolic processes necessary for successful hatching. Also, with the findings of Christensen (1995) who reported that physiological doses of thyroxine and triiodothyronine of 50 and 25 ng, respectively, injected at day 25 of incubation significantly improved hatchability in turkey embryos. In addition, EL-Nagar et al. (2005 & 2007) found that hatchability improved, embryonic mortality decreased and weight of one-day-old chicks increased significantly compared to control by the administration of thyroxine to Japanese quail hens and hens of local strain.

Moreover, the results reflected metabolic responses to light via increase in biochemical constituents of blood plasma in embryos under light regime. These embryos had significant ($P \leq 0.0001$) increases in plasma biochemical parameters such as total protein, albumen, globulin, glucose, total lipids, cholesterol and triglycerides by 27, 50, 19, 83, 29, 28, and 55%, respectively compared to those kept at dark incubation. This indicates that light regime helps to increase the metabolic rate in developing embryos. This may in turn increase embryonic plasma T_3 levels. Many investigators found positive correlation between thyroid hormones and metabolic rate, development and differentiation of chicken embryos (Decuypere et al., 2005; Lu et al., 2007). Thyroid hormones (THs) have multiple effects on vertebrate metabolism and development. In homeothermic animals, THs regulate basal metabolic rate and are essential for the maintenance of high and constant body temperature. The effect of THs on protein and lipid metabolism is of a biphasic nature: in low physiological concentrations they are anabolic while at higher concentrations they are catabolic. During development THs stimulate both growth and differentiation (or maturation). Their action can be direct, indirect or permissive. Most of the actions of THs seem to be dependent on the binding to a nuclear thyroid hormone receptor (Zation et al., 1993; Decuypere et al., 2005).

A study suggests that thyroid hormones can activate GH synthesis and synergistically stimulate GH expression with glucocorticoids in rat pituitary cell lines (Yaffe and Samuels, 1984). However, thyroid hormones appear to require glucocorticoids to regulate GH gene expression and somatotroph differentiation in fetal animals. Chicken embryonic pituitary cells in culture indicate that the synergistic actions of glucocorticoids and thyroid hormones occur directly on the somatotroph precursor population to induce an increase in the absolute abundance of GH-producing cells (Liu et al., 2003).

Other researchers reported that light incubation improves embryonic growth by induced gene expression during the growth process which probably produces particular gene products (proteins, enzymes or regulatory molecular substances) (Ghatpande et al., 1995). Also, Rozenboim et al. (1999) reported that lighting elevated embryonic plasma androgens, enhancing protein synthesis and reducing protein breakdown (Bates et al., 1987).

CONCLUSIONS

In conclusion, the results of this study indicated that light regime incubation improved embryonic growth, hatchability percentage and chicks performance after hatching by increasing production and release of thyroid hormones, especially T_3, which is responsible for elevating embryonic metabolic rate. This is apparent via mobilization of biochemical constituents in blood of developing embryos.

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REFERENCES

ABIOLA, S. S. – MESHIOYE, O. O. – OYERINDE, B. O. – BAMGBOSE, M. A. 2008. Effect of egg size on hatchability of broiler chicks. *Arch. Zootech.,* vol. 57, 2008, p. 83-86.

Al-MOHSEN, T. H. – SHAFEY, T. M. 2004. Effects of fluorescent light during incubation on embryonic growth, hatchability traits and hatch times of meat breeder eggs. *J. King Saud Univ. Agric. Sci.,* vol. 16, no.1, 2004, p. 35-47.

BATES, P. C. – CHEW, L. F. – MILWARD, D. J. 1987. Effects of the anabolic steroid stanozolol on growth and protein metabolism in the rat. *J. Endocrinology,* vol.114, 1987, p. 373-381.

BOWLING, J. A. – HOWARTH, B. – FLETCHER, D. L. 1981. The effects of lighted incubation on eggs with pigmented and nonpigmented egg. *Poult. Sci.,* vol. 60, 1981, p. 2328-2332.

CHRISTENSEN, V. L. 1995. Factors affecting hatchability of turkey embryos. *Poult. Avian Biol. Rev.,* vol. 6, 1995, p. 71-82.

COOPER, J. B. 1972. Effect of light during incubation on hatchability of turkey eggs. *Poult. Sci.,* vol. 51, 1972, p.1105–1108.

DECUYPERE, E. – VAN AS, P. – VAN DER GEYTEN, S. – DARRAS, V.M. 2005. Thyroid hormone availability and activity in avian species. *A Review Domestic Animal Endocrinology,* vol. 29, 2005, p. 63–77.

EL-NAGAR, S. A. – HANAA KHALIL, M. – MAYSA HANAFY, M. – El-SHEIKH, A.M. 2005. Thyroid hormones and hens reproductive performance of two local strain. *Egypt. Poult. Sci.,* vol. 25, 2005, p. 147-165.

EL-NAGAR, S. A. – ZEWEIL, H. S. – BASMA MANSOUR, A. A. 2007. Relationship between thyroid hormones and reproductive functions in Japanese quail kept under different systems of photoperiods. *Egypt. Poult. Sci.,* vol. 27, 2007, p. 281-308.

FAIRCHILD, B. D. – CHRISTENSEN, V. L. 2000. Photo-stimulation of turkey eggs accelerates hatching times without affecting hatchability, liver or heart growth or glycogen content. *Poult. Sci.,* vol. 79, 2000, p. 162-1631.

GHATPANDE, A. – GHATPANDE, S. – KHAN, M. J. 1995. Effect of different intenstties of fluorescent light on the early development of chick embryos in ουο. *Cellular and Molecular Biology Research,* vol. 41, 1995, p. 613-621.

ISAKSON, S. T. – HUFFMAN, B. J. – SIEGEL, P. B. 1970. Intensities of incandescent light and the development of chick embryos in ουο and in vitro. *Biochem. Physiol.,* vol. 35, 1970, p. 229-235.

JERRY, V. 1984. Influence of the pineal gland and circadian rhythms in circulating levels of thyroid hormones of male hamsters. *J. Pineal Research,* vol. 1, 1984, p. 15-22.

LAAKSA, M. L. – PORKKA-HEISKANEM, T. – STENBERG, D. – JOHANSSON G. – MANNISTO, P. T. 1990. Lighting conditions affect serum and pituitary TSH in male rats. *AJP-Endocrinology and Metabolism,* vol. 259, 1990, p. 162-169.

LIU, L. – CARLTON, E. – PORTER, T. 2003. Thyroid hormones interact with glucocorticoids to affect somatotroph abundance in chicken embryonic pituitary *Cells in Vitro. Endocrinology,* vol. 144, 2003, p. 3836-3841.

LU, J. W. – MCMURTRY, J. P. – COON, C. N. 2007. Developmental changes of plasma insulin, glucagon, insulin-like growth factors, thyroid hormones, and glucose concentrations in chick embryos and hatched chicks. *Poult. Sci.,* vol. 86, 2007, p. 673-683.

NARUSHIN, V. G. – ROMANOV, M. N. 2002. Egg physical characteristics and hatchability. *J. Worl's Poult. Sci.,* vol. 58, 2002, p. 297-303.

NESTOR, K. E. – NOBLE, D. O. 1995. Influence of selection for increased egg production, body weight, and shank width of turkeys on egg composition and the relationship of the egg traits to hatchability. *Poult. Sci.,* vol. 74, 1995, p. 427-433.

OTTENWELLER, J. E. – HEDGE, G. A. 1982. Diurnal variations of plasma thyrotropin, thyroxine, and triiodothyronine in female rats are phase shifted after inversion of the photoperiod. *Endocrinology,* vol. 111, 1982, p. 509-514.

PETWK, M. – BASPINAR, H. – OGAN, M. 2003. Effects of egg weight and length of storage on hatchability and subsequent growth performance of quail. *South African J. Anim. Sci.,* vol. 33, 2003, p. 242-247.

ROZENBOIM, I. – BIRAN, I. – UNI, Z. – ROBINZON, B. – HALEVY, O. 1999. The effect of monochromatic light on broiler growth and development. *Poult. Sci.,* vol. 78, 1999, p. 135-138.

SAS Institute, 1998. SAS statistical guide for personal computer, SAS Institute Inc. Cary, NC.

SHAFEY, T. M. 2004. Effect of lighted incubation on embryonic growth and hatchability performance of two strains of layer breeder eggs. *British Poult. Sci.,* vol. 45, 2004, p. 223-229.

SHAFEY, T. M. – Al-MOHSEN, T. H. 2002. Embryonic growth, hatching time and hatchability performance of meat breeder incubated under continuous green light. *Asian-Australasian J. Anim. Sci.,* vol. 15, 2002, p. 1702-1707.

WITTKOWSHI, W. – BERGMANN, M. – HOFFMANN K. – PERA F. 1988. Photoperiod-dependent changes in TSH-like immunoreactivity of cells in the hypophysial pars

tuberalis of the Djungarian hamster, *Phodopus sungorus*. *Cell and Tissue Research,* vol. 251, 1988, p. 183-187.

YAFFE, B. M. – SAMUELS, H. H. 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.,* vol. 259, 1984, p. 6284-6291.

YAKIMENKO, I. – BESULIN, V. – TESTIK, A. 2002. The effects of low intensity red laser irradiation on hatching eggs in chicken and quail. *Int. J. Poult. Sci.,* vol.1, 2002, p. 06-08.

ZAKARIA, A. H. 1989. The effect of fluorescent light on hatchability of commercial broiler parent stock eggs and on body weight of chickens hatched under large-scale commercial conditions. *Poult. Sci.,* vol. 68, 1989, p. 1585-1587.

ZATION, Z. – MERICAN, Z. – KHALIL, B. A. – MOHAMED, J. B. – BAHAROM, S. 1993. The effects of propranolol on skeletal muscle contraction, lipid peroxidation products and antioxidant activity in experimental hyperthyroidism. *Gen. Pharmacol.,* vol. 24, 1993, p. 195-199.