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CHANGING LIGHTING AND FEEDING TIME TO ALLEVIATE THE DELETERIOUS EFFECT OF HOT ASSIUT SUMMER ON PERFORMANCE OF JAPANESE QUAIL

M. F. A. Farghly

Department of Animal and Poultry Production, Faculty of Agriculture, University of Assiut, Egypt

SUMMARY

This study was conducted to investigate the effects of lighting and feeding time management (at morning or afternoon) on productive and reproductive performance of Japanese quail in the hot summer of Assiut. Two hundred and forty unsexed one-day old chicks were reared in batteries and assigned to 4 groups (60 birds /each). The birds of first and second groups (C and T1), were exposed to light at the morning (1000 to 2200) and fed twice daily at 1000 and 1600 h as well as 2200 and 0400 h, respectively. The third and fourth groups (T2 and T3) were exposed to light at the afternoon (2200 to 1000) and fed twice daily at 1000 and 1600 h as well as at 2200 and 0400 h, respectively. All the other conditions were the same during the experimental period. Birds were supplied with clean water all the time. The results showed that change feeding and lighting time to afternoon significantly ($P \leq 0.05$) improved growth performance, body temperature, egg number, egg quality and fertility percentage. While, no significant differences ($P \leq 0.05$) existed in hatchability, egg weight and egg components. In conclusion, feeding Japanese quail at afternoon coincide with light is a good and economical managerial tool to alleviate the harmful effects of high temperature stress during the summer season at Assuit.

Keywords: **performance, feeding and lighting time, hot summer, Japanese quail.**

INTRODUCTION

High temperature is considered one of the important factors affecting poultry production, consequently profitability during the summer in hot climates above 30°C especially in Upper Egypt. As temperature rises, the bird has to maintain the balance between heat production and heat loss, thus it will reduce its feed consumption by 5% for every 1 ºC rise in temperature between 32-38ºC to reduce heat from metabolism this lead to reduced growth rate as compared to its genetic potential (Geraert *et al.,* 1996 and Morêki, 2008). Regard to the heat production associated with feeding, therefore, birds would be facing problematic conditions when the feeding is at around 1000-1100 h, as the heat of feed utilization coincides with the hottest part of the day (Wilson *et al*., 1989; Saiful *et al.,* 2002; Yahav and Hurwitz, 1996).

Although the advanced developments in building design, ventilation and cooling management, we are still faced with eliminating high temperature effects. Many lighting and feeding manipulations have been proposed to prevent or lessen the production losses. Feeding and lighting time management could be used to overcome the negative effects of high temperature on poultry performance during hot weather (Aengwanich, 2007; Gharib *et al.,* 2008 and El-Badry *et al.,* 2009). Light allows the bird to synchronize many essential functions, including body temperature and various metabolic pathways that facilitate feeding and digestion. As birds generally only eat during the photoperiod, heat production associated with birds feeding would be at this time. Therefore, birds would be facing problematic conditions when the lighting time is at midday, as the heat of feed utilization coincides with the hottest part of the day especially in hot climates. Feed withdrawal and darkening treatments at midday improved the respiration rate, body temperature and immune responses (Saiful *et al.,* 2002 and El-Badry *et al.,* 2009).

Several methods are available to alleviate the effect of high environmental temperature, consequently improve the productive and reproductive performance of poultry. Since it is expensive to cool poultry buildings, such methods are focused mostly on the managerial manipulations. Therefore, the main objective of this study is the management of feeding and lighting time to improve productive and reproductive performance of Japanese quail in the hot summer of Assiut.

MATERIALS AND METHODS

The present study was carried out at the poultry research farm of the Animal and Poultry Production Department, Faculty of Agriculture, Assiut University, Assiut, Egypt. The experiment lasted during summer season (from May to October 2010), where the environmental temperature ranged from 22.4 to 28.3 °C at night and 31.6 to 35.9°C at midday while, humidity was from 40.4 to 63.4% (Table 1). Two hundred and forty unsexed one-day old Japanese quail chicks (Coturnix coturnix japonica) were reared in batteries and assigned to 4 groups (60 birds /each). The birds of first and second groups (C and T1), were exposed to light at the morning (1000 to 2200) and fed twice daily at 1000 and 1600 h as well as 2200 and 0400 h, respectively. The third and fourth groups (T2 and T3) were exposed to light at the afternoon (2200 to 1000) and fed twice daily at 1000 and 1600 h as well as at 2200 and 0400 h, respectively. All the other conditions were the same during the experimental period. Birds were supplied with clean water all the time. Birds per each group, 60 birds (30 males and 30 females), were housed in quail brooding batteries with dimensions of 86 X□50 X□25 cm pens from hatch until sexual maturity. Subsequently, the quail were transferred into productive battery individual cages (20 X□ 25 X□ 30 cm) throughout the laying period. The composition and calculated analysis of the experimental diets are shown in Table (2).

The newly hatched chicks were exposed to continuous lighting for 24 hrs/day during the first 3 days of age. Thereafter, the photoperiod was decreased gradually (one hr/wk) to be adjusted to 12 hrs (growing) and 16 hrs (laying) lighting regimens with light intensities of 10 and 20 Luxes, respectively. The body weight (BW) on individual basis, at 0, 4, 8, 12, 16, 20 and 24 weeks of age was recorded. The average body weight gain (BWG) was calculated biweekly from 0 to 8 weeks of age. The feed consumption (FC) was calculated biweekly, from 0 to 24 weeks of age. The feed conversion values during the growing period (g feed/g gain, FCRg) were calculated periodically every four weeks, from 0 to 8 weeks of age. The feed conversion ratio values during the laying period (g feed/g egg mass, FCRe) were calculated periodically every four weeks, from 8 to 24 weeks of age. Egg weight, egg number and egg production as hen-housed production (HHP) were calculated periodically every four weeks, from 8 to 24 weeks of age. Body temperature (ºC) was measured by using a thermometer inserted into the rectum for 2 minutes at depth of 2 cm in midday biweekly. Dead birds were recorded daily and expressed as percentage during the experimental period.

Table 1. The overall means of indoor temperature and relative humidity values during the experimental period

Intervals	Temperature (C°)			Humidity (%)		
(Month)	Max.	Min	Av.	Max.	Min.	Av.
May	31.6	22.8	27.2	63.4	42.1	52.8
Jun	32.7	24.6	28.7	62.2	41.4	51.8
Jul	35.4	26.2	30.8	61.3	41.2	51.3
Aug	35.9	28.3	32.1	60.9	40.4	50.7
Sep	34.8	26.2	30.5	61.8	41.4	51.6
Oct	33.8	23.6	28.7	62.5	41.8	52.2
Overall mean	**34.0**	**25.3**	**29.7**	**62.0**	**41.4**	**51.7**

Max = Maximum Min= Minimum Av. = Average

Table 2. Composition and calculated analysis of the experimental diets

Ingredients	Starter (%)	Layer (%)
Yellow corn	53.0	52.3
Soybean meal (44%)	34.6	31.7
Concentrate	12.0*	10.0**
NaCl	0.25	0.50
Dicalcium phosphate	0.15	1.50
Limestone	---	4.00
Total	**100**	**100**
	Calculated analysis* **	
Protein (%)	26.0	23.6
ME (KCal/ Kg diet)	2850	2775
Calcium (%)	0.90	2.75
Available phosphorus (%)	0.45	0.75

* Broiler concentrate contains: 52% crude protein 1.6% crude fiber6.1%, ether extract 7%, calcium 3.5% available phosphorus 1.5% methionine, 2.1% methionine and cystine , 3.0% lysine 2416 kcal/ kg metabolizable energy. Each Kilogram of broiler concentrate contains the following levels of vitamins and minerals: vit. A 130,000 IU; D3 26,000 IU; vit. E 120 IU; vit B12 150 ug; vit. K3 MSB 16 mg; vit B2 50 mg; capantothenate B3 120 mg; nicotinic acid PP 250 mg ; thiamine B1 25 mg; folic acid 15 mg; betain-Choline- HCl 5000 mg; Mn 700 mg;Zn 600 mg; Fe 400 mg;Cu 40 mg; Iodine 7 mg; Se 1.5 mg; B.H.T. 1250 mg; Zinc baciteracin 150 mg.

** The layer concentrate contains: Crude protein, 51.00%- Lysine, 3.30%- Crude fiber, 2.00% - Calcium, 8.00% -Crude fat ,6.40 % - Available phosphorus,3.00%- Methionine,1.7 %-Salt, 3.19%- Methionine+Cystine,2.25%- Metabolizable energy 2400 kcal/. Each Kilogram of layer concentrate contains the following levels of vitamins and minerals: Vit. A , 10000 IU - Folic acid , 10 mg -Vit. E, 100 mg – Biotin, 500 mg - Vit. D3, 2500 IU - Chorine chloride 5000 mg - Vit. K, 25 mg- Iron, 400 mg - Vit. B1, 100 mg – Zinc,560 mg- Vit. B2,40 mg- Copper , 5 mg- Vit. B6, 15mg – Iodine, 3 mg- Vit. B12, 200 mg- Selenium, 1mg-Pantothenic acid, 100 mg- Manganese, 620 mg- Niacin, 400 mg - Antioxidant75 mg.

*** Calculated according to NRC (1994).

During the period from 12 to 24 weeks of the experiment, 360 fresh-laid eggs were taken, every four weeks, from each group to measure egg quality characteristics. Egg weight was recorded to the nearest 0.1 gram on the same day of collection using a special automatic digital balance. The length and width of eggs were determined using a sliding caliper and egg shape index was determined according to Reddy *et al.* (1979) as egg shape index = (width of egg/length of egg)x 100. All eggs were broken gently on a glass surface. The height of thick albumen and yolk were measured using a micrometer, as described by Brant and Shrader (1952). The diameter of yolk was measured, using a sliding caliper. The yolk was separated from the albumen and weighted. Shells with membranes were dried and weighed to the nearest 0.01 gm. Haugh units were calculated for individual eggs from the egg weight and albumen height values (Doyon *et al.,* 1986), using the following formula: Haugh unit = 100 log (H- 1.7 x w 0.37 + 7.6) Where: H = the observed height of the albumen in millimeters and W = weight of egg (g).

Yolk index was calculated by dividing yolk's height/ yolk's diameter x100. Shell thickness of the dried shell (without membranes) was measured using shell thickness apparatus and the average was recorded (0.01 millimeters). The albumen weight was calculated by subtracting shell and yolk weight from egg weight. The egg components were expressed as percentages of the egg weight. Eggs laid in all experimental groups were collected daily and stored 7 days at 15-18ºC and 70-75% relative humidity before incubation. Four hatches were performed at 12, 16, 20 and 24 weeks of age. The incubation was carried out using automatic Patersime setter and hatcher. The fertility and hatchability percentages were calculated as follow: Fertility (%) = number of fertile eggs x100/ total set eggs. True hatchability (%) = number of hatched chicks x100/ total fertile eggs.

Economical efficiency was based on the costs of the feed consumed and the income/bird (body weight and fertile egg production). The net revenue per bird is estimated as the difference between the total income/bird (LE), (growth and fertile egg production) and the total costs of feed and others. The costs of the used diets were calculated according to the actual prices prevailing in the Egyptian market during the time of experiment.

Statistical analysis was performed according to one-way analysis of variance in this experiment using GLM procedure of SAS, version 6.12, 1996. The following model was used for analysis of variance:

$$\mathbf{Y_{ij} = \mu + S_i + e_{ij}}$$

Where:

Y_{ij} = observation, μ = overall mean,

S_i = treatment effect, e_{ij} = experimental errors.

Duncan separation of means method (1955) was used to detect significant differences among means of different groups. The percentages of HHP, fertility and hatchability were transformed to Arcsin values before the statistical analysis.

RESULTS AND DISCUSSSION

Body weight (BW) and Body weight gain (BWG):

The results presented in Table (3), showed significant differences ($P \leq 0.05$) in BW and BWG for all the experimental groups at all studied ages except at 0, 2 and 4 weeks of age for BW as well as at 0-2 weeks of age for BWG. The overall mean of T1, T2 and T3 had a significantly higher ($P \leq 0.05$) ABWG than those of C by about 6.4, 9.7 and 6.4 %, respectively.

Table 3. Means ± SE of growth traits of Japanese quail as affected by feeding and lighting time

Traits	Age (wks)	Treatments			
		C	T1	T2	T3
Body weight (g)	0	7.61±0.91	7.55±0.61	7.72±0.92	7.81±0.61
	2	53.6±2.11	55.8±1.88	56.4±1.96	54.4±2.66
	4	123.6±2.11	126.2±3.22	128.2±3.14	125.3±3.22
	6	166.4 ^{b}±3.38	174.8^{ab}±4.22	180.4^{a}±2.31	175.1^{ab}±4.52
	8	196.6^{b}±3.42	208.0^{a}±5.56	216.8^{a}±3.52	209.2$^{.a}$±4.22
	12	198.2^{b}±4.68	209.8^{a}±4.62	218.2^{a}±3.21	211.4 ^{a}±3.26
	16	197.9^{b}±5.25	208.6^{ab}±5.22	219.7^{a}±4.12	214.2^{a}±4.02
	20	202.0^{c}±4.02	212.2^{b}±4.66	221.9^{a}±3.12	215.8^{ab}±4.12
	24	205.0^{c}±3.22	212.8^{bc}±3.11	222.8^{a}±4.22	215.6^{ab}±3.71
Body weight gain (g/bird/day)	0 - 2	3.29±0.22	3.45±0.16	3.47±0.11	3.33 ±0.16
	2 - 4	4.99 ^{c}±0.31	5.03 ^{b}±0.10	5.13^{a}±0.15	5.01 ^{b}±0.21
	4 - 6	3.10 ^{c}±0.12	3.47 ^{b}±0.26	3.73 ^{a}±0.12	3.56 ^{b}±0.12
	6 - 8	2.20 ^{c}±0.11	2.36^{b}±0.22	2.60 ^{a}±0.22	2.44 ^{ab}±0.11
	Overall mean	**3.37 ^{b}±0.16**	**3.58^{a}±0.32**	**3.73 ^{a}±0.16**	**3.60 ^{a}±0.21**
Feed consumption (g/bird/day)	0 - 2	8.66±0.55	8.88±0.47	8.49±0.51	8.80±0.68
	2 - 4	12.72±0.72	12.99±0.72	12.82±0.66	13.11±0.69
	4 - 6	14.62±0.83	14.58±0.62	14.92±0.74	15.12±0.98
	6 - 8	17.00±0.81	17.18±0.92	17.58±0.81	17.66±1.01
	8 - 12	16.99±1.01	17.11±0.92	18.24±1.03	18.32±1.11
	12 - 16	18.73±1.21	19.01±0.82	19.68±0.91	20.12±1.01
	16 - 20	20.39±1.10	20.69±0.78	21.69±0.68	22.11±0.91
	20 - 24	20.65±0.91	20.71±0.93	21.97±0.92	22.12±0.78
	Overall mean	16.22±0.89	16.39±0.96	16.92±0.88	17.17±1.0
Feed conversion (g feed/g gain) (FCRg)	0 - 2	2.63±0.11	2.57±0.10	2.44±0.10	2.64±0.08
	2 - 4	2.54 ±0.18	2.58 ±0.11	2.50 ±0.08	2.59 ±0.09
	4 - 6	4.78 ^{a}±0.20	4.20 ^{b}±0.08	4.00^{b}±0.10	4.25 ^{b}±0.20
	6 - 8	7.90 ^{a}±0.12	7.27 ^{ab}±0.21	6.76 ^{b}±0.20	7.25 ^{ab}±0.31
	Overall mean	4.46 ^{a}±0.18	4.15 ^{ab}±0.13	3.92 ^{ab}±0.11	4.18 ^{ab}±0.14
Feed conversion (g feed/g egg mass) (FCRe)	8 - 12	3.59 ^{a}±0.13	3.10 ^{b}±0.09	2.89 ^{b}±0.09	3.49 ^{a}±0.12
	12- 16	2.77 ^{a}±0.05	2.57 ^{ab}±0.07	2.46 ^{b}±0.08	2.63 ^{ab}±0.07
	16 – 20	2.61 ±0.10	2.49 ±0.11	2.49 ±0.14	2.68 ±0.14
	20 - 24	2.65 ±0.14	2.41 ±0.11	2.35 ±0.13	2.65±0.12
	Overall mean	2.90 ±0.11	2.64 ±0.95	2.55 ±0.11	2.86 ±0.11

a---c Means within row followed by different superscripts are significantly different ($P \leq 0.05$).
C = Birds exposed to light at morning (1000 to 2200) and fed twice daily at 1000 and 1600 h.
T1= Birds exposed to light at morning (1000 to 2200) and fed twice daily at 2200 and 0400 h.
T2 = Birds exposed to light at afternoon (2200 to 1000) and fed twice daily at 1000 and 1600 h.
T3 = Birds exposed to light at afternoon (2200 to 1000) and fed twice daily at 2000 and 0400 h.

When temperatures remain at a high level for a long period of time, birds will find it increasingly difficult to reduce their heat production leading to decrease feed consumption resulting in lowering growth rate. Researches have shown that each 3°C increase in ambient temperature over 33°C will reduce growth by 0.9% in chicken (Meltzer, 1987; Yahav and Hurwitz, 1996). Similar results were reported by Abbas *et al.* (2007) and Gharib *et al.* (2008) who found that body weight of chicken reared under high temperature and intermittent light program was significantly higher than the continuous light. Also, Donkoh *et al.* (1989) found that when birds received lighting during the night they had significantly higher body weight gain compared to other groups. Classen *et al.* (2004a) demonstrated that the darkness period tend to limit growth rate due to preventing of regular access to feed and water.

Regarding feeding time, feeding birds during hot part of day led to increasing the heat load, due to the heat produced during feed metabolism. This leads to a remarkable depression in the available metabolizable energy for growth (Marai *et al.,* 2006). Our results are agreement with the results of Hassan *et al.* (2003), Bouvarel *et al.* (2004), and Farghly (2010) who stated that birds fed at the afternoon had significantly ($P \leq 0.05$) higher body weight and body weight gain than those of birds fed at midday. On the contrary, Harms (1991) and Samara *et al.* (1996) found a decrease in body weight and body weight gain when birds were fed at the afternoon.

Feed consumption (FC) and feed conversion (FCR):

The obtained results presented in Table (3), showed insignificant differences in feed consumption (FC) values in the experimental four groups at all ages studied. However, the differences in average FCR during the experimental periods from 4-6 and 6-8 weeks of age for growth (FCRg) as well as from 8-12 and 12-16 weeks of age for egg (FCRe) were significant ($P \leq 0.05$).

It is known that poultry prefer to eat during the light period, although they will eat during darkness if insufficient periods of light are provided (Simmons, 1982). Therefore, birds would be facing problematic conditions when the lighting time is at midday, as the heat of feed utilization coincides with the hottest part of the day. So, change of the lighting time from morning to evening was among managerial alternatives used to improve FCR of hens maintained under hot climate (Bootwalla *et al.,* 1983 and Wilson and Keeling, 1991). Donkoh *et al.* (1989) found that birds received lighting during the night had significantly higher feed consumption compared to the other groups.

Most of the reduction in feed consumption and feed efficiency in hot climate is due to reduced maintenance requirement, consequently, decrease the appetite of birds (Marai *et al.,* 2006 and Morêki, 2008). Our results coincided with the findings of Keshavarz (1998), Veltmann *et al.* (1984) and Farghly (2010). They found that FC and FCR for broilers fed at the afternoon was superior to the other groups. However, Roland *et al.* (1972) found that feeding the Japanese quail during the period from 1400 to 2200 h increased FCR above those of quail fed from 0600 to1400 h.

Body temperature (BT):

Data presented in Table (4), show significant differences ($P \leq 0.05$) in body temperature (°C) between the experimental four groups starting at 8 weeks of age. The average body temperature (ABT) of T1, T2 and T3 groups were significantly ($P \leq 0.05$) lower than those of C group at 8, 12, 20 and 24 weeks of age. The ABT of T2 and T3 groups were significantly ($P \leq 0.05$) lower than those of C group at 16 weeks of age.

Table 4. Means ± SE of Body temperature and mortality rate of Japanese quail as affected by feeding and lighting time

Traits	Age (wks)	Treatments			
		C	T1	T2	T3
Body temp. (C°)	0	39.82±0.27	39.68±0.27	39.98±0.08	39.89±0.40
	2	40.58±0.18	40.72±0.25	40.81±0.30	40.71±0.06
	4	40.92±0.30	40.88±0.16	40.48±0.90	40.79±0.30
	6	40.96±0.12	40.92 ±0.23	40.78±0.14	40.92±0.07
	8	41.44 [a]±0.18	40.96 [b]±0.10	40.72 [b]±0.07	40.78 [b]±0.18
	12	42.10 [a]±0.13	41.14 [b]±0.23	41.10 [b]±0.18	41.12 [b]±0.19
	16	42.21 [a]±0.14	41.78 [ab]±0.10	41.12[c]±0.16	41.34 [bc]±0.20
	20	41.92 [a]±0.18	41.32 [b]±0.01	40.78 [b]±0.17	41.27 [b]±0.20
	24	42.21 [a]±0.16	41.66 [b]±0.14	40.85 [c]±0.13	41.32 [bc]±0.14
Mortality rate (%)	0 - 8	5.80	4.23	3.40	3.20
	8 - 24	3.82	3.42	2.22	2.82
	0 - 24	9.6 2	7.65	5.62	6.02

a-----c Means within row followed by different superscripts are significantly different (P≤0.05).
C = Birds exposed to light at morning (1000 to 2200) and fed twice daily at 1000 and 1600 h.
T1= Birds exposed to light at morning (1000 to 2200) and fed twice daily at 2200 and 0400 h.
T2 = Birds exposed to light at afternoon (2200 to 1000) and fed twice daily at 1000 and 1600 h.
T3 = Birds exposed to light at afternoon (2200 to 1000) and fed twice daily at 2000 and 0400 h.

The body temperature of a bird varies between 40 and 42°C, depending on the time of day (before and after feeding, night time), feather cover, brooding, and environmental temperature (Donkoh, 1989). During darkness period, melatonin reduces heat production by lowering body temperature and regulating heat dissipation (Shoukry *et al.,* 1993; Rozenboim *et al.,* 1998 and Apeldorn *et al.,* 1999). El-Badry *et al.* (2009) found that feed withdrawal and darkness improved the respiration rate, body temperature and immune responses of muscovy ducks. However, Carmen *et al.* (1991) found that food withdrawal or darkness during heat stress had no significant effect on body temperature.

Heat production increased after 3 to 5 hrs of feeding. This is associated with about +1°C rise in body temperature (Cave, 1981; Leeson and Summers, 2000, and Avila *et al.,* 2003a). Also, Wiernusz and Teeter (1993) and Koh *et al.* (2000) observed that heat production and body temperature increased with feed consumption. Aperdoorn *et al.* (1999) reported that chickens had lower heat production during the second and third hours of the dark period than the chickens under continuous light.

Mortality rate:

The data presented in Table (4), showed that, the mortality rate of the four studied groups ranged between 3.2 and 5.8% for growing period and between 2.2 and 3.8% for laying period and between 5.6 and 9.6% for all the experimental period. Introduction of photoperiod during temperate climate, consequently feeding is associated with potential welfare benefits, including lower physiological stress, improved immune response, increased sleep and increased overall activity (Gordon, 1994; Davis *et al.,* 1997 and Classen *et al.,* 2004b).

The present results agree with the observations of Marai *et al.* (2002) who found that exposing birds to high temperature during midnight increased the mortality rate. On the contrary, Avila *et al.* (2003b) found that the feeding time had no effect on mortality. Naughton *et al.* (2002) and Bölükbasi and Emsen (2006) found that during heat exposure period, under the continuous light, the mortality rate was almost twice as compared with intermittent lighting program.

Egg production (EP):

The data presented in Table (5) revealed significant differences (P≤0.05) in the egg number (EN) and hen housed production (HHP) among birds of the experimental groups at all ages studied. The total of EN and average HHP for T2 group was significantly (P≤0.05) higher than that of C group. The overall mean of HHP and total EN for T2 group was significantly (P≤0.05) higher than that of C group by 13.7 and 13.6 %, respectively.

Table 5. Means ± SE of egg number, hen housed production and egg weight for Japanese quail as affected by feeding and lighting time

Traits	Periods	Treatments			
		C	T1	T2	T3
Egg number (egg/hen/28 days)	P1 (8 -12 w)	12.6 ^{b} ±0.63	14.4 ^{ab}±1.1	16.4^{a}±0.50	13.7 ^{b} ±0.70
	P2 (12 -16 w)	17.5 ^{b} ±0.3	18.8 ^{ab}±0.70	20.2 ^{a} ±0.07	19.4 ^{a} ± 0.80
	P3 (16- 20 w)	19.6^{b}±0.42	20.5^{ab}±0.50	21.5 ^{a}±0.40	20.5^{ab}±0.53
	P4 (20- 24 w)	19.2^{b} ±0.7	20.3^{ab} ±0.64	21.9 ^{a}±0.40	19.9 ^{b}±0.50
	Total	69.0 ^{b} ±2.0	74.1 ^{ab}±2.9	79.9 ^{a} ±1.4	73.6 ^{ab}±2.50
Egg weight (g)	P1 (8 -12 w)	10.5±0.20	10.7±0.12	10.8 ±0.07	10.7 ±0.25
	P2 (12 -16 w)	10.8±0.24	11.0±0.20	11.2 ±0.13	11.1 ±0.24
	P3 (16- 20 w)	11.2±0.30	11.4 ±0.18	11.4 ± 0.07	11.3 ±0.21
	P4 (20- 24 w)	11.4±0.40	11.9±0.12	12.0 ±0.13	11.8±0.21
	Overall mean	10.9 ±0.30	11.3±0.15	11.4 ±0.11	11.2 ±2.50
Hen housed production (HHP ,%)	P1 (8 -12 w)	45.1 ^{b} ±2.3	51.6^{ab}±3.9	58.4 ^{a} ±1.8	49.1 ^{b}±2.50
	P2 (12 -16 w)	62.6 ^{b} ±1.03	67.2 ^{ab}±2.5	72.1 ^{a} ±0.24	69.4 ^{a}±2.70
	P3 (16- 20 w)	70.1 ^{b}±1.50	73.3^{ab} ±1.7	76.9 ^{a} ±1.4	73.4^{ab} ±1.90
	P4 (20- 24 w)	68.6 ^{b}±2.50	72.6 ^{ab}±2.6	78.1 ^{a} ±1.5	71.1 ^{b}±1.71
	Overall mean	61.6 ^{b} ±1.82	66.1 ^{ab}±2.60	71.4 ^{a} ±1.2	65.7 ^{ab}±2.20

a-----b Means within row followed by different superscripts are significantly different (P≤ 0.05).
C = Birds exposed to light at morning (1000 to 2200) and fed twice daily at 1000 and 1600 h.
T1= Birds exposed to light at morning (1000 to 2200) and fed twice daily at 2200 and 0400 h.
T2 = Birds exposed to light at afternoon (2200 to 1000) and fed twice daily at 1000 and 1600 h.
T3 = Birds exposed to light at afternoon (2200 to 1000) and fed twice daily at 2000 and 0400 h.

The harmful effects of high temperature on egg production are not only due to a reduction in feed consumption but also by a disruption of hormones responsible for ovulation and a decrease in responsiveness of granulosa cells to luteinizing hormone (Donoghue *et al*., 1989 and Novero, 1991). Laying hens increase their calcium intake during the evening as eggshells are normally formed during this time (Morêki, 2008). Also, Hsu *et al.* (1998) found that high temperature decreases significantly egg production and egg weight. On the contrary, Farmer *et al.* (1983); Bootwalla *et al.*

(1983) and Brake and Peebles (1986) found that afternoon feeding in chickens increased the egg weight.

The obtained results are in agreement with observations of Wilson *et al.* (1989), who reported that in feeding the birds during the hot time of the day leads to heat stress, due to the heat increment that happen during feed metabolism. The findings of Duncan and Hughes (1975) and Hassan *et al.* (2003) suggest that quail fed from 1400 to 2200 h had higher egg production rate. Moreover, the herein results agree with observations of Balnave (1977), Avila *et al.* (2003b) and Farghly (2010) who found that the afternoon feeding resulted in a higher rate of egg production. On the contrary, Brake and Peebles (1986) and Harms (1991) found that feeding hens during the afternoon caused a reduction in egg production. However, Brake (1988), Wilson and Keeling (1991) and Samara *et al.* (1996) who, noted that afternoon feeding had no effect on egg production.

Egg quality traits:

Data presented in Table (6), indicated that, there are significant differences (P>0.05) in average of egg weight (AEW), egg shape index (ESI), egg yolk index (EYI) and egg components (Albumen%, Yolk%, Shell%) due to change lighting and feeding time. However, significant differences (P≤0.05) in the shell thickness (ST) and Haugh units (HU) were present among birds in the experimental groups. The average ST of T2 group had significantly higher (P≤0.05) than those of C group. T

Table 6. Means±SE of egg quality traits and egg components for Japanese quail as affected by feeding and lighting time

Traits	Treatments			
	C	T1	T2	T3
Egg weight (g)	10.92 ±0.26	10.94 ±0.21	11.1 ±0.20	11.0 ±0.32
Egg shape index (%)	74.61±0.82	75.1±1.50	76.1±0.52	75.2±0.36
Egg yolk index (%)	54.80±1.1	55.0±0.4	55.6± 0.5	55.2±0.5
Haugh units	89.42^{b}±0.6	90.3^{ab}±0.70	91.3^{a}±0.33	89.1^{b}±0.33
Egg shell thickness (x 0.01 mm)	18.5^{b}±0.24	19.4^{ab}±0.42	19.9^{a}±0.32	19.4^{ab}±0.41
Albumen (%)	54.62±1.0	55.30±1.1	55.36±1.11	55.11±1.1
Yolk (%)	36.88±1.64	35.56±0.41	35.41±1.61	36.31±0.9
Shell (%)	8.45 ±0.40	9.11 ±0.50	9.21 ±0.33	8.62 ±0.38

a-----b Means within row followed by different superscripts are significantly different (P≤ 0.05).
C = Birds exposed to light at morning (1000 to 2200) and fed twice daily at 1000 and 1600 h.
T1= Birds exposed to light at morning (1000 to 2200) and fed twice daily at 2200 and 0400 h.
T2 = Birds exposed to light at afternoon (2200 to 1000) and fed twice daily at 1000 and 1600 h.
T3 = Birds exposed to light at afternoon (2200 to 1000) and fed twice daily at 2000 and 0400 h.

The average Haugh unit (HU) of the T2 group was significantly (P≤0.05) higher than those of C and T3 groups. High temperature may produce adverse effects on egg quality traits, such as eggshell thickness and egg specific gravity by reducing calcium intake and metabolism, interfering with the calcium carbonate formation in the shell and upsetting the acid-base balance in the blood and limits the amount of CO3 available for eggshell formation (Teeter and Smith, 1986; Odom *et al*., 1986; Hsu *et al.,* 1998 and Morêki, 2008).

An additional advantage of feeding at the afternoon is the availability of calcium in the digestive system during shell formation at night, consequently shell quality will improve. The obtained results are in partial agreement with observations of

Lennards *et al.* (1981), Bootwalla *et al.* (1983), Brake and Peebles (1986), Brake (1988) and Harms (1991). They reported that feeding hens at the afternoon had an important role in the ability of laying hens to calcify eggshells as compared with morning feeding. However, Wilson and Keeling (1991) and Samara *et al.* (1996) found that feeding time had no effect on egg components and quality.

Fertility and hatchability (%):

The results presented in Table (7) revealed significant ($P \leq 0.05$) increase in the average of fertility percentage (F %) of T1 group over the C group at 16, 20 and 24 weeks of age. Also, the overall mean of F% for T2 exceeded significantly ($P \leq 0.05$) that of C by 9.0 %. It is well known that high ambient temperature increase body temperature, which has negative effect on gamete formation and the fertilization process resulting in low fertility (Morêki, 2008).

Table 7. Means ± SE of fertility and hatchability of Japanese quail eggs as affected by feeding and lighting time

Age (wks)	Fertility (%)				Hatchability (%)			
	C	T1	T2	T3	C	T1	T2	T3
12	81.3 ±3.82	83.9±4.31	87.1±2.92	85.8 ±4.62	61.6 ±1.69	63.1±3.88	62.8 ±3.62	60.6 ±2.33
16	83.6^{b}±1.61	88.5^{ab}±2.12	91.6^{a}±3.01	89.4^{ab}±3.61	65.9 ±1.86	66.3 ±2.42	68.8 ±3.11	64.2 ±4.22
20	86.5^{b}±1.98	90.2^{ab}±2.75	94.6^{a}±1.93	92.4^{ab}±2.32	66.2 ±2.57	69.0±4.72	67.7 ±3.61	65.1±3.21
24	82.2^{b}±2.72	90.6^{ab}±2.52	92.9^{a}±2.59	91.4^{ab}±3.15	65.2 ±1.74	66.6±3.66	69.5 ±2.51	64.3 ±3.11
Overall mean	83.4^{b}±1.88	88.30^{ab}±2.52	91.6^{a}±3.11	89.8^{ab}±2.75	64.7 ±3.22	66.2 ±4.11	67.2 ±3.42	63.6±3.22

a-----b Means within row followed by different superscripts are significantly different ($P \leq 0.05$).
C = Birds exposed to light at morning (1000 to 2200) and fed twice daily at 1000 and 1600 h.
T1= Birds exposed to light at morning (1000 to 2200) and fed twice daily at 2200 and 0400 h.
T2 = Birds exposed to light at afternoon (2200 to 1000) and fed twice daily at 1000 and 1600 h.
T3 = Birds exposed to light at afternoon (2200 to 1000) and fed twice daily at 2000 and 0400 h.

A relationship between mating time and lighting time, consequently feeding time was observed. Mating activity is usually in the highest rate in late afternoon (Harms, 1991; Leeson and Summers, 2000). Similar results of Brake (1988), Hassan *et al.* (2003), Petek (2008) and Farghly *et al.* (2010) were reported. They stated that feeding hens in the afternoon resulted in higher fertility than those fed in the morning. However, Bootwalla *et al.* (1983) found no effect of feeding time on fertility. The improvement of egg quality and egg production of quail fed at the afternoon may be the reason for the improved fertility. As for hatchability, the obtained results are in disagreement with the observations of McDaniel *et al.* (1979), Brake (1988) and Farghly (2010) who reported that afternoon feeding improves hatchability. However, the findings of Farmer *et al.* (1983) indicated that afternoon feeding decreased hatchability.

Economical efficiency:

The data presented in Table (8), showed that, birds fed from 2000 to 2400 h and exposed to light at afternoon (T2) had higher economical efficiency as compared to the other three groups (C, T1 and T3) during growing and laying periods, since, it amounted 100, 108.6, 112.2 and 104.5 for growing period as well as100, 116.0, 125.0 and 108.4 for laying period, respectively. Gordon (1994), Morris (2004) Campo *et al.* (2007), and Farghly *et al.* (2010) reported similar results.

Table 8. Economical efficiency of Japanese quail as affected by feeding and lighting time

Items		C	T1	T2	T3
		Treatment			
Growing period:					
Total costs/ bird (L.E)	Total feed consumption (kg/bird)	0.95	0.96	0.98	0.99
	Total feed costs (L.E)	2.14	2.16	2.22	2.23
Total revenue (bird/L.E)	Selling price of bird at 8 weeks of age (L.E)	4.71	5.00	5.20	5.02
Net revenue/ bird/L.E (without constant costs=25%)		**2.58**	**2.83**	**2.99**	**2.80**
Economical efficiency/ bird (EE)		**1.20**	**1.31**	**1.35**	**1.26**
Relative economical efficiency/ bird (REE)		**100.0**	**108.6**	**112.2**	**104.5**
Laying period:					
Total costs/ bird/L.E	Total feed consumption (kg/bird)	2.15	2.17	2.28	2.31
	Total feed costs (L.E)	4.30	4.34	4.57	4.63
Total revenue/ bird/L.E	Fertile egg number/hen	57.6	65.4	73.2	66.1
	Selling price for fertile eggs/hen/L.E	20.2	22.9	25.6	23.1
Net revenue/ bird/L.E (without constant costs= 25%)		**15.85**	**18.56**	**21.06**	**18.51**
Economical efficiency/ bird (EE)		**3.69**	**4.28**	**4.61**	**4.00**
Relative economical efficiency/ bird (REE)		**100.0**	**116.0**	**125.0**	**108.4**

Cost of 1 kg of live body weight = 24.00 L.E. Price of 1 fertile egg = 0.35 L.E. L.E = Egyptian pound.
Price of 1 kg of growing and laying ration = 2.25 & 2.10 L.E EE/bird=Net revenue per unit of total costs
C = Birds exposed to light at morning (1000 to 2200) and fed twice daily at 1000 and 1600 h.
T1= Birds exposed to light at morning (1000 to 2200) and fed twice daily at 2200 and 0400 h.
T2 = Birds exposed to light at afternoon (2200 to 1000) and fed twice daily at 1000 and 1600 h.
T3 = Birds exposed to light at afternoon (2200 to 1000) and fed twice daily at 2000 and 0400 h.

It could be concluded that the feeding birds at afternoon and lighting (T2) was more economically efficient as compared to other groups. This could be attributed to the superiority of T2 in growth and egg performance as well as having adequate percentages of fertility. In addition, T2 decreased the body temperature of birds, which was positively reflected on the health condition of the birds. The feeding and lighting at afternoon gave the best results in terms of performance and total net returns and therefore should be encouraged.

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تغيير وقت الإضاءة والتغذية لتخفيف التأثير الضار لصيف أسيوط الحار على أداء السمان الياباني

محمد فرغلى علم الدين فرغلى

قسم الإنتاج الحيواني والدواجن، كلية الزراعة، جامعة أسيوط، مصر

إستهدف هذا البحث دراسة تأثير تغيير وقت التغذية و الإضاءة على الأداء الإنتاجي والتناسلي للسمان الياباني خلال فصل الصيف الحار في أسيوط. تم تربية ٢٤٠ كتكوت من السمان الياباني عمر يوم غير مجنس في بطاريات قسمت إلي أربعة مجاميع (مقارنة , ٣ معاملات), و قسمت الطيور بكل مجموعة والبالغ عددها ٦٠ طائر إلى ثلاثة مكررات بواقع ٢٠ طائر/مكررة. عرضت طيور المجموعة الأولى والثانية للإضاءة صباحا (١٠٠٠ إلى ٢٢٠٠) و غذيت مرتين يوميا, عند الساعة ١٠٠٠ ثم الساعة ١٦٠٠, وعند الساعة ٢٢٠٠ ثم ٠٤٠٠ على التوالي بينما عرضت المجموعة الثالثة و الرابعة للإضاءة مساءا (٢٢٠٠ إلى ١٠٠٠) و غذيت مرتين يوميا, عند الساعة ١٠٠٠ ثم الساعة ١٦٠٠, وعند الساعة ٢٢٠٠ ثم ٠٤٠٠ على التوالي وكان يتم تزويد جميع الطيور بالماء طوال الوقت. أوضحت النتائج المتحصل عليها أن تغيير وقت التغذية والإضاءة إلى المساء في صيف أسيوط الحار أدى إلى تحسين أداء النمو, صفات إنتاج البيض, جودة البيض, نسبة الخصوبة, حرارة الجسم وبالتالي الكفاءة الاقتصادية للسمان الياباني, ولكنه ذو تأثير غير معنوي على نسب مكونات البيضة ووزن البيضة ونسبة الفقس في المجموعات الأربعة. الخلاصة: تغذية طيور السمان مساءا متزامنا مع فترة الإضاءة تعتبر وسيلة رعائية اقتصادية جيدة لتخفيف التأثيرات الضارة لإجهاد الحرارة العالية خلال فصل الصيف في أسيوط.