EFFECT OF HOUSING CONDITIONS ON PERFORMANCE OF JAPANESE QUAIL (*Coturnix coturnix japonica*) UNDER COLD STRESS IN WINTER

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SUMMARY

The effect of different housing conditions on body weight, weight gain, feed intake, water consumption, egg production, rectal temperature, hematocrit value and mortality rate were studied in Japanese quail. Three experimental groups: winter conditions (control), long day-light (lighted) and hot climate (heated) were used. A total of 195 quail chicks (65/group, 40 females and 25 males) were used. Results showed that significant differences in the most studied traits occurred among the treatment groups. Winter conditions had a significantly lighter body weight compared to the other groups between 6 to 14 weeks of age. During this period, rectal temperature was significantly higher in winter group compared to the other groups. Egg production was the lowest in the control group compared to the other groups. Birds kept under high environmental temperature had the lowest hematocrit value than the other treatment groups. In general, Egyptian winter conditions had adversely influence on most studied traits in Japanese quail. It is assumed, therefore, that during winter increased lighting period and ambient temperature are important to increase productive and reproductive cycles in Japanese quail by enhancing physiological responses.

Keywords: Japanese quail, cold stress, light period, egg production, rectal temperature, hematocrit value

INTRODUCTION

Light period and ambient temperature are two environmental variables principally affecting certain activities associated with productive and reproductive cycles in birds (Farner, 1964). The influence of photoperiodism on gonadal activity, sexual maturity, feed consumption, weight gain and egg production in Japanese quail was investigated by many research groups (Brain *et al.,* 1988; Chaturvedi *et al.,* 1991; Tsuyoshi and Wada, 1992; Wada, 1993; Canonaco *et al.,* 1994 and Bonn *et al.,* 2001). Temperature during rearing is a major factor in production efficiency for chickens (May and Lott, 2000). Ambient temperature has been reported to influence the productive and reproductive traits in previous works (Mohan *et al.,* 1990 and Khalil, 1998).

Photoperiod plays an important role in the development of gonads in both male and female quails. The role of photoperiod information is to stimulate the hypothalamus area via eyes and extra-retinal photoreceptors, that provides inputs to the hypothalamus area to secrete gonadotropin-releasing hormone (GnRH), which

controls secretions of FSH and LH hormones. In males, LH controls the production of the major sex steroid (testosterone) secreted by Leydig cells in the testes. In females, the secretion of FSH and LH controls the secretion of estrogen, necessary for yolk precursor lipoprotein secretion by the liver, oviduct and follicle development. Gonadotropin-releasing hormone stimulate gonadal development, eventually resulting in onset of lay (Bacon *et al.,* 1980; Dunn and Sharp, 1990 and Lewis *et al.,* 1999). Day length has a major effect on protein synthesis rates, this effect will determine the overall growth of chicks subjected to differing day lengths (Bonn *et al.,* 2001). When Japanese quail chicks were raised on long (16h light/d) or short (8h light/d) photoperiods from 22 to 70 days of age, only the quails raised on the long photoperiod layed eggs, starting between 42 and 49 days of age (Brain *et al.,* 1988). The objective of this research was to study the effect of increasing photoperiod and ambient temperature during winter on the performance and thermoregulatory response in Japanese quail. Normal Egyptian winter conditions of temperature and light were compared with artificially prolonged daylight and an artificially increased ambient temperature.

MATERIALS AND METHODS

Birds and husbandry

The experiment was carried out at the Poultry Farm, Department of Animal Production, Faculty of Agriculture, Suez Canal University, Ismailia, Egypt during winter months (November till April). Chicks were kept under normal brooding conditions in brooding batteries 3 weeks of age, under continuous lighting and with a gradual decrease in room temperature from 37°C at hatching to 25°C at 3 weeks of age .

At 3 weeks of age, 195 birds were randomly distributed into three experimental groups and transferred to experimental floor pens (3x3 m). Each group consisted of 65 chicks (25 males and 40 females). Both feed and water were provided *ad libitum*. All the chicks were wing numbered. The three experimental groups were classified as following. The first group (control) was kept under natural climatic conditions of the winter season, averaged light period (11.3 h/d), mean temperature (19.02°C) and mean relative humidity (53%). The second group (lighted group) had similar conditions as winter group except that day light-length was extended artificially to be 16 hours daily. The last group (heated group) was kept under natural winter day light and averaged relative humidity (44%) but ambient temperature raised to 31-32°C.

Studied Traits

The live body weights of the males and females were recorded at 3, 4, 5, 6, 8, 10, 12 and 14 weeks of age. Feed and water consumptions were recorded throughout the experiment. The daily egg production rates were recorded up to 15 weeks of age. Sexual maturity, laying rate (%), egg number, egg weight (g) and egg mass (g) were recorded. Body temperature (°C) was recorded weekly, starting at 3 till 14 weeks of age on twenty birds randomly (10 males and 10 females) from each group by inserting thermometer 1.5 cm into the rectum for 30 second.

Blood samples were taken for measuring the hematocrit value. The samples were collected by cardiac puncture using a heparinized syringe. One hundred and twenty samples were obtained randomly at 12 and 14 weeks of age from 16 birds from each treatment group (8 males and 8 females). The hematocrit was measured after

centrifuging the sample at 3000 (r/min) for 15 minutes. Mortality rates were determined at the end of the experimental period.

Statistical Analysis

Data were analysed using the General Linear Model (GLM) procedure of SAS (SAS, 1990).

RESULTS AND DISCUSSION

Body weight and weight gain

The initial body weight of three-week-old quail birds was nearly similar between the three treatments and ranged between (97.84-102.57 and 102.02-107.07 g) for males and females, respectively (Table 1). With age progress significant differences ($P \leq 0.05$) among treatments in females body weights were found. The lightest body weights were obtained in females kept under winter conditions, while the heaviest body weights were obtained in females kept under long day photoperiod and high environmental temperature. At 10 and 12 weeks of age, females kept under long day photoperiod had significantly heavier live body weights than females kept under other housing conditions. Considering males body weight, there were no significant differences between housing conditions in males live body weight at all ages studied, except at 6 and 8 weeks of age.

Table 1. Body weights (g) of male and female quail kept under different housing conditions (LSQ-Means ± SD)

Age (wks)	Sex	Housing conditions		
		Control	Lighted	Heated
3	Male	102.57±12.44	97.84±11.14	98.28±8.96
	Female	107.07±19.13	102.02±9.11	102.57±10.57
4	Male	142.62±17.99	138.21±15.89	137.24±10.34
	Female	147.32±14.17	145.25±11.71	141.05±10.81
5	Male	171.00±17.28	175.28±20.58	171.52±13.01
	Female	182.62±16.93	182.17±18.35	177.58±10.39
6	Male	182.28±16.15^{b}	195.36±23.39^{a}	188.44±18.41^{ab}
	Female	196.00±16.22^{b}	209.37±18.06^{a}	210.94±12.32^{a}
8	Male	182.54±17.33^{b}	198.36±27.38^{a}	204.64±23.31^{a}
	Female	195.81±16.56^{b}	232.11±29.59^{a}	234.75±16.89^{a}
10	Male	197.62±17.50	209.29±25.55	206.16±23.32
	Female	210.91±21.21^{c}	243.05±25.14^{a}	230.71±24.22^{b}
12	Male	195.15±21.21	204.08±28.08	203.48±25.21
	Female	206.89±20.61^{c}	242.61±26.92^{a}	228.81±26.44^{b}
14	Male	198.50±24.21	206.29±24.51	212.96±24.82
	Female	214.32±25.61^{b}	243.21±26.95^{a}	239.11±22.72^{a}

^{a,b,c} Means in any row with no common superscript differ ($P \leq 0.05$).

It must be mentioned that males kept under normal Egyptian conditions had the lightest values of body weight from 5 weeks old until the end of the experiment at 14 weeks of age. The average body weight gain values of quail chicks raised under different housing conditions revealed significant differences due to the housing conditions at most studied ages. From 3-4 weeks weight gain did not differ significantly between housing conditions. Weight gain of males was significantly higher in lighted group than in the control group during 4-5, 5-6 and 3-6 weeks of age. On the other hand, from 5-6 and 3-5 weeks females weight gain was significantly lower in control group compared with other groups. Average weight gain of male and female quails raised under winter conditions, long day photoperiod and high environmental temperature were (82.01, 97.52 and 90.16g for males and 90.93, 107.35 and 108.37g for females) from 3 to 6 weeks of age, respectively. In general, quails raised under the winter conditions had the least weight gain than those from other housing conditions (Table 2).

Table 2. Weight gain (g) in male and female quail kept under different housing conditions (LSQ-Means ± SD)

Age (wks)	Sex	Housing conditions		
		Control	Lighted	Heated
3-4	Male	40.05±9.28	40.36±7.01	38.96±4.96
	Female	40.25±15.56	43.22±7.49	38.47±6.16
	Overall	40.11±13.25^{ab}	41.79±6.22^{a}	38.71±5.55^{b}
4-5	Male	28.37±12.73^{b}	37.08±10.12^{a}	34.28±5.55^{ab}
	Female	35.31±9.591	36.92±14.54	36.66 ±7.74
	Overall	31.85±5.24^{b}	37.01±11.26^{a}	35.47±7.81^{ab}
5-6	Male	12.58±5.24^{b}	20.08±11.02^{a}	16.91±7.81^{ab}
	Female	14.17±6.54^{c}	27.21±15.47^{b}	33.34±10.35^{a}
	Overall	13.37±6.01^{b}	23.64±13.27^{a}	25.12±10.11^{a}
3-6	Male	82.01±10.21^{b}	97.52±15.14^{a}	90.16±10.11^{ab}
	Female	90.93±10.92^{b}	107.35±16.21^{a}	108.37±15.21^{a}
	Overall	86.47±9.11^{b}	102.43±15.61^{a}	99.25±13.61^{a}

^{a,b,c} Means in any row with no common superscript differ (P≤0.05).

These results are consistent with previous investigations. There are a correlation between rearing photoperiod and productivity of Japanese quail, because long day photoperiod resulted in increasing the period of feed intake and stimulated the gonadotropin hormones and sex hormones secretion, which are responsible for growth and sexual maturity (Dunn and Sharp, 1990 and Lewis *et al.,* 1999). Also, day length has a major effect on protein synthesis rates (Bonn *et al.,* 2001).

Feed and water consumptions and feed conversion

The amount of feed consumed/chick for chicks kept under control, lighted and heated conditions were (443.52, 480.51 and 467.27g) through 3 to 6 weeks old, respectively (Table 3). The amounts of feed consumed/chick increased with long photoperiod. On the other hand high housing temperature and short photoperiod/day (normal Egyptian conditions) decreased the amounts of feed consumed/chick. The respective feed conversions were 5.1, 4.7 and 4.7. Lighting and heating, obviously, resulted in better efficiency of feed utilization. The amount of water consumed/chick of chicks kept under natural winter condition (control), lighting and heating were (557.3, 594.0 and 825.1 ml) through 3 to 6 weeks old, respectively. Chicks kept under high environmental temperature consumed more water than those under the other housing conditions. These results agree with those obtained by Macled and Dabutha (1997) who found that, water consumption (ml) increased with increased temperature (by about 60 % at 35°C).

Table 3. Feed intake, feed conversion and water consumption in quail with respect to housing conditions

Parameters	Age (wks)	Housing conditions		
		Control	Lighted	Heated
Feed intake (g)	3-4	141.33	120.50	132.11
	4-5	149.17	177.17	165.9
	5-6	153.02	182.84	169.26
	3-6	443.52	480.51	467.27
Feed conversion	3-4	3.523	2.883	3.418
	4-5	4.683	4.787	4.677
	5-6	11.411	7.613	6.731
	3-6	5.129	4.691	4.708
Water consumption (ml)	3-4	184.5	198.5	250
	4-5	183.8	197.9	285.3
	5-6	189.1	197.6	289.7
	3-6	557.3	594	825.1

Sexual maturity

Results in Table (4) showed that, quails raised under the Egyptian natural winter conditions (control) had delayed age at 12 % laying than the long day photoperiod and high ambient temperature conditions (98, 46 and 40 days, respectively). Significant differences ($P \leq 0.05$) in body weight at 12 % egg laying were found due to housing conditions mean while, birds kept under high environmental temperature had significantly less body weight than those kept under natural winter conditions and long-day photoperiod by about 6.90%.

Table 4. Egg production parameters with respect to housing conditions from 5 to 15 weeks of age (LSQ-Means ± SD)

Parameters	Housing conditions		
	Control	Lighted	Heated
Age at 12 % egg Production (day)	98	46	40
Body weight at 12 % egg Production (g)	215.02±24.28[a]	215.15±15.61[a]	200.23±9.88[b]
Egg number/hen (n)	2.11	36.17	42.92
Egg weight (g)	11.41± 0.88[a]	11.05± 1.01[b]	10.79± 1.05[b]
Egg mass/hen (g)	24.07	399.60	461.39

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

Egg production trait:

Laying rate, egg number, weight and mass

Average weekly percentage of egg production as affected by housing conditions from 5 to 15 weeks of age are presented in (Figure 1). Birds kept under high environmental temperature showed a rapid start of egg laying at 5 weeks of age. They showed 50% laying rate at the 7th week with successive increase to reach its maximum (86.91 %) at 10 weeks, thereafter, it decreased slowly up to 13 weeks (57.40 %) when it increased again up to 15 weeks to be 75%. Birds kept under long day light photoperiod showed rapid start of egg laying at 5 weeks, the 50% rate of lay was recorded at the 8th week and increased to reach its peak (70.27 %) at 11 weeks of age, thereafter, it decrease at the 12th week (62.65 %) and increased again up to the end of the experiment. Birds kept under winter condition (control) showed delayed egg laying to the 11th week of age. Rate of lay was increased slowly with age to reach (11.58 %) at the end of the experiment.

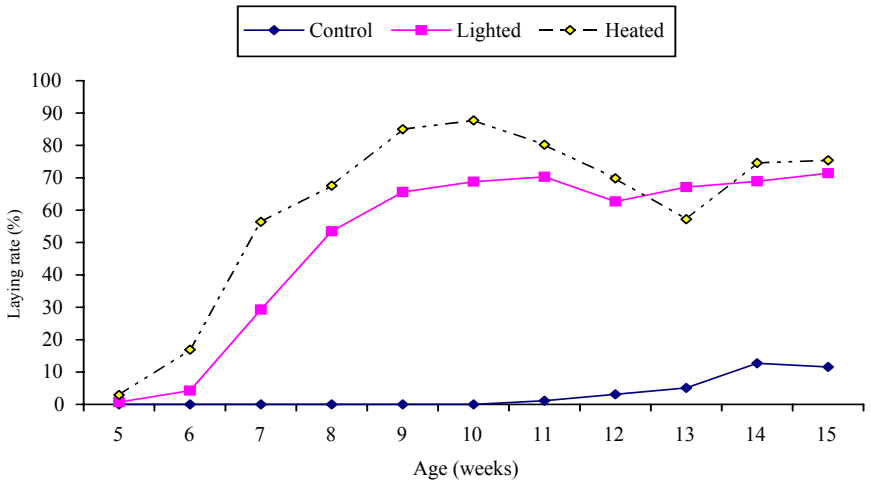

Fig. 1. Laying rate with respect to housing conditions

Quail birds kept under high environmental temperature gave higher number of eggs and greater egg mass through 5 to 15 weeks of age (42.92 egg and 464.39g, respectively), while lower values were obtained from birds kept under normal Egyptian winter conditions (2.11 eggs and 24.07g, respectively). Birds kept under winter conditions had significantly heavier egg weights than those kept under long day photoperiod and high environmental temperature (11.41, 11.05 and 10. 79g, respectively).

These results are consistent with Kuit (1980) and Brake & Baughman (1989) who reported that increasing daylight (16h/d) resulted in an earlier onset of lay and sexual maturity, less feed consumed per hen to peak egg production, improved feed conversion, an earlier age at peak egg production, higher peak egg production and more total egg production per hen than under a regimen with an 8h photoperiod supplied by daylight during the growing period in broiler breeders. Wilson *et al.,* (1970) found that egg production was greater and the weights of gonads and oviducts were significantly larger, the egg weight was smaller in Japanese quail kept under hot environment 32°C with short day (8h/d) than in quail kept under a cold environment 10°C with short day (8h/d).

Hematocrit values

Hematocrit values did not differ significantly between the three groups at any age in male. While, significant difference was found in female at 12 and 14 weeks of age. Females kept under high environmental temperature had the lower hematocrit values than quails kept under both winter conditions (control) and long day photoperiod at 12 and 14 weeks of age. In General, birds kept under high environmental temperature had the lower hematocrit values than quails kept under both winter conditions (control) and long day photoperiod (39.82, 41.06 and 45.87 % at 12 weeks of age and 39.53, 43.92 and 42.85 % at 14 weeks of age), respectively (Table 5).

These results agree with Shlosberg *et al.* (1992) who found that cold-stressed birds show a rapidly developing elevated hematocrit. Hematocrit values at 42 day of age ranged between 27 to 55%, the higher values being caused by exposure to low ambient temperatures (Shlosberg and Bellaivhe, 1996). Lowered hematocrit is caused by less erythrocytes and no more fluid in the blood volume or smaller erythrocytes.

The definition of high and low hematocrit is somewhat difficult as this may vary greatly, depending on environmental factors related to ambient temperature, age, sex, water intake, dietary sodium, copper and iron (Goodwin *et al.,* 1992). In the present study a negative correlation was found between water consumed and hematocrit value (-0.39) with highly significant correlation (Table 6). These results indicate that high environmental temperature causes decreases in hematocrit values by increased water consumption.

Table 5. Hematocrit values of male and female quails with respect to housing conditions (LSQ-Means ± SD)

Age (wks)	Sex	Housing conditions		
		Control	Lighted	Heated
12	Male	45.98±4.31	45.23±3.27	45.05±2.82
	Female	45.77±5.91^{a}	36.89±5.94^{b}	34.59±3.99^{b}
	Overall	45.87±4.67^{a}	41.06±5.01^{b}	39.82±3.25^{b}
14	Male	46.01±3.03	45.62±1.10	42.63±4.71
	Female	39.69±5.81^{ab}	42.22±3.66^{a}	36.43±3.99^{b}
	Overall	42.85±4.75	43.92±2.56	39.53±4.25
Overall	Male	46.17±3.51	45.43±2.38	43.84±3.56
	Female	42.73±5.85^{a}	39.56±4.56^{a}	35.71±3.98^{b}
	Overall	44.45±4.31^{a}	42.49±3.85^{ab}	39.77±3.64^{b}

^{a,b} Means in a row with no common superscript differ ($P \leq 0.05$).

Rectal temperature

After birds were randomly distributed into the three experimental groups and transferred to the experimental floor pens, the rectal temperature rose rapidly in all experimental groups up to the 5th week in heated and lighted groups and at 6th week in control group, after that rectal temperature dropped in all experimental groups (Fig. 2). In general, rectal temperature was significantly higher in birds kept under normal Egyptian conditions than in those from the other two experimental groups at 6, 7, 9 until 14 weeks of age irrespective of sex. This indicates that lighting and heating groups acclimatized more rapidly than the normal group. Because the decreased rectal temperature indicates that, these birds had increased food and energy intake and the metabolic process is normal (Sykes and Silah, 1986). On the other hand, the correlation between rectal temperature and acclimatized are given. The negative correlation was found between rectal temperatures with feed intake and water consumption with highly significant correlation (-0.27 & -0.23), respectively (Table 6).

Correlation estimates

The results of correlation coefficients between some studied traits showed that, positive correlation was found between body weight and both feed intake and water consumption with highly significant correlation (Table 6). In contrast, negative correlation was found between both rectal temperature and hematocrit value and both feed intake and water consumption with highly significant correlation. These results indicated that, increase of feed intake follow-up increase in body weight. On the other hand, increase of water consumption follow-up decrease in hematocrit rate.

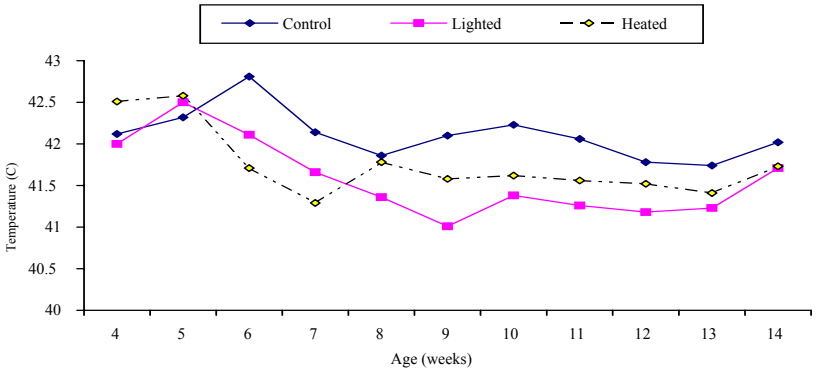

Fig. 2. Weekly average of rectal temperature (°C) of quail with respect to housing Conditions till 14 weeks of age

Table 6. Correlation coefficients between rectal temperature (°C) and productive traits, across housing conditions

	RT	BW	HT	FC	WC
RT	1.000	0.03ns	-0.02ns	-0.27**	- 0.23**
BW		1.000	-0.12ns	0.23**	0.27**
HT			1.000	-0.16**	-0.39**
FC				1.000	0.56**
WC					1.000

RT= rectal temperature, BW= body weight, HT= hematocrit value,
FC= feed conversion, WC= water consumption

Mortality rate

Mortality rates of males and females, as affected by housing conditions are presented in Table (7). Females had a higher mortality rate than males (11.66 vs. 2.66%, respectively), irrespective of treatments. Also, higher mortality rates were obtained in birds housed under long day photoperiod compared to those kept under both high environmental temperature and winter conditions (10.66, 7.69 and 6.16%, respectively), during the experimental period. The reason of high mortality rate in the lighted group compared to other groups may be return to activity and sexual actives of birds under long day photoperiod.

Table 7. Total mortality rate of male and female quail at 14 weeks of age with respect to housing conditions

Age (wks)	Sex	Housing conditions							
		Control		Lighted		Heated		Total	
		No	%	No	%	No	%	No	%
Initially housed	Male	25		25		25		75	
	Female	40		40		40		120	
	Total	65		65		65		195	
At 14 wk	Male	1	4.00	1	4.00	0	0.00	2	2.66
	Female	3	7.50	6	15.00	5	12.5	14	11.66
	Total	4	6.15	7	10.76	5	7.69	16	8.20

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دراسة أثر نظم الإيواء على أداء السمان اليابانى تحت ظروف الجو البارد فى فصل الشتاء

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إستهدفت هذه التجربة دراسة تأثير طول فترة الإضاءة أو زيادة درجة الحرارة أثناء فترة التربية على أداء السمان اليابانى تحت ظروف الجو البارد (فصل الشتاء) فى محافظة الإسماعيلية بجمهورية مصر العربية. حيث اشتملت هذه التجربة على مقارنة الظروف الطبيعية للشتاء من حرارة وإضاءة (مجموعة الكنترول) وبزيادة مدة الإضاءة الصناعية إلى 16 ساعة يوميا مع درجات حرارة الشتاء (مجموعة الإضاءة) وأيضا برفع درجة الحرارة إلى (31-32 درجة مئوية) مع فترة الإضاءة اليومية خلال الشتاء (مجموعة الحرارة). حيث تم استخدام 195 كتكوت سمان (65 كتكوت / مجموعة تجريبية، 25 ذكر + 40 أنثى). وكانت أهم النتائج المتحصل عليها ما يلى:

أظهرت النتائج أن هناك فروق معنوية بين المعاملات الثلاثة فى معظم الصفات الإنتاجية المدروسة. حيث لوحظ أن الطيور المرباة تحت ظروف الشتاء الطبيعية (الكنترول) كانت اقل معنويا فى كلا من وزن الجسم وإنتاج البيض وكانت الأعلى معنويا فى درجة حرارة الجسم مقارنة بالمعاملتين الأخيرتين ابتداء من الأسبوع السادس إلى نهاية التجربة. كما أشارت النتائج إلى وجود فروق معنوية بين المعاملات فى نسبة المكونات الخلوية للدم (الهيماتوكريت) عند الأسبوع 12 و 14 من العمر حيث كانت القيم الأقل للطيور المرباة تحت ظروف الحرارة العالية مقارنة بمجموعتي الكنترول والإضاءة. كما تفوقت الذكور على الإناث فى قيم الهيماتوكريت بغض النظر عن المعاملات. كما أوضحت النتائج أن هناك ارتباط سالب بين درجة حرارة الجسم وكلا من الهيماتوكريت والكمية المستهلكة من العلف والماء وكذلك بين الهيماتوكريت والكمية المستهلكة من العلف والماء.

وخلاصة هذه الدراسة توضح أن الظروف البيئية المصرية من حرارة وإضاءة خلال فصل الشتاء لها تأثير عكسى على معظم الصفات الإنتاجية والتناسلية المدروسة لدى السمان اليابانى، حيث توصى هذه الدراسة الى زيادة درجات الحرارة وكذلك زيادة فترة الإضاءة لرفع الكفاءة الإنتاجية والتناسلية للسمان اليابانى تحت الظروف البيئية المصرية فى فصل الشتاء.