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CHANGES IN THYROID HORMONES DURING THE EGG LAYING CYCLE IN FAYOUMI HENS

(With 4 Tables)

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التغييرات فى هرمونى الغدة الدرقية أثناء دورة
وضع البيض فى الدجاج الفيومى

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أجريت هذه الدراسة بغرض تقدير مستوى هرمونى الغدة الدرقية الثيروكسين وثالث ايودید الثيرونين والهرمون الحاث لنشاطهما فى الدجاج الفيومي أثناء دورة وضع البيض وكذلك في الدجاج الغير بياض · كما أجرى تقدير لمعدل إستهلاك هرمونى الغدة الدرقية وقياس متوسط العمر البيولوجي لهما بهدف الوصول إلى توضيح العلاقة بين هرمونى الغدة الدرقية وإنتاج البيض في الدجاج الفيومي · كما كان مستوى هرمون الثيروكسين منخفضا بشكل واضح عند وضع البيض وحتى ١٢ ساعة بعد ذلك ، ثم إرتفع معنويا بعد ٢٠ ساعة ، بينما في الدجاج غير البياض كان مستوى هذا الهرمون عاليا نسبيا · وقد إستمر مستوى هرمون ثلاثى ايودید الثيرونين بدون تغير ملموس في الدجاج البياض أثناء مراحل وضع البيض ، بينما كان مرتفعا في الدجاج غير البياض · كما كان مستوى الهرمون الحاث للغدة الدرقية في المصل منخفضا عند فترة وضع البيض وكان أعلي مستوى له عند ١٢ ساعة · أما فى الدجاج غير البياض فكان مستواه منخفضا كما تبين أن فترة نصف العمر البيولوجي لهرمون الثيروكسين في الدجاج البياض طويلة عند ٢٠ ساعة بعد وضع البيض ، بينما كانت قصيرة عند فترة وضع البيض ولا نهائية بعد ١٢ ساعة من وضع البيض · وفى الدجاج غير البياض كانت فترة نصف العمر البيولوجي لهذا الهرمون طويلة جدا · أما بالنسبة لهرمون ثلاثى ايودید الثيروكسين فقد كان معدل إختفائه من الدم سريع عند ١٢ ساعة من وضع البيض · وخلاصة القول فإن معدل إفراز هرمونى الغدة الدرقية وكذلك معدل إمتصاصهما من القناة الهضمية وأيضا معدل إختفائهما من مصل الدم يتوقف على دورة إنتاج البيض في الدجاج البياض وتختلف عنها في الدجاج غير البياض · لذا فإن ضبط فترة إعطاء هرمونى الثيروكسين وثلاثى ايودید الثيرونين يعود بنتائج مشجعة نحو زيادة معدل إنتاج البيض في الدجاج الفيومى ·

SUMMARY

The aim of the present study was to determine the levels of T_4, T_3 and TSH in the serum of laying and non laying Fayoumi chickens. The biological half life of exogenous T_4 and T_3 was also measured in these chicken to elucidate the relationship between the thyroid hormones and egg production.

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The results obtained revealed that:

The level of serum T_4 during the egg laying cycle varied significantly. At the time of laying, serum T_4 was relatively low and still low at 12 h. Then it reached its maximal level at 20 h after egg laying. The levels of T_3 in serum did not show any significant variation during all stages of egg laying cycle. Significantly high level of serum T_3 was observed in non-laying hens.

The lowest level of TSH was observed at egg laying, while the maximal level was observed a time around 12 h after egg laying. In non-laying hens serum TSH was low.

The biological half-life of T_4 was long in hens 20 h from egg laying, while it was shorter at egg laying. In non-laying hens $t_{1/2}$ of T_4 was very long. The rate of disappearance of T_3 from circulation of laying hens was more rapid at 12 h after egg laying.

It is not simply a matter of increased or decreased secretion of T_4 and T_3 during the egg laying cycle, but extends to selective absorption or inhibition of absorption of T_4 and T_3 by alimintary tract. It includes also variations in utilization of T_4 and T_3 at a certain time in the egg laying cycle which is different from non laying hens.

INTRODUCTION

It has been reported by several investigators that there is a close relationship between thyroid activity of hens and production of eggs (PECZEL et al., 1980; KANSAL and GAGWAR, 1983 and SZELENYLE et al., 1985).

It is also clear that the mechanism regarding control and metabolism of thyroid hormones as correlated with the ovulatory cycle of hens is of great importance. Studies by AWAD (1979), SOLIMAN et al. (1979 and 1980) showed that the thyroid of hens exhibit cyclic activity during the egg laying cycle, being very active after ovulation by 15 to 16 h. This phase of egg laying cycle appears to be accompanied with intensive metabolic activities. In this species there is also increased rate of turnover of thyroid hormones (SINPH et al., 1967).

The knowledge of variation in thyroxine and triiodothyronine levels and their rate of absorption and degradation during the ovulatory cycle of hens could possibly lead to devising the quantity and quality of egg production. The aim of present study is to determine the biological half lifes of exogenous thyroxine (T_4) and triiodothronine (T_3) during the stages of formation of the egg during the egg laying cycle.

MATERIALS and METHODS

Thirty eight Fayoumi hens, six months old, with an average weight 1.00±0.20 Kg were used. They were kept in seperate cages in laying metal battaries and feta a layer ration. They ere allowed to drink water ad libitum and exposed to twelve hour light system. The average duration of egg laying cycle was determined, which took 30.5 h on average. The hens were classified into three groups (10 each) according to the time of egg laying, namely zero hour (representing the time of egg laying), 12 and 20 hour after egg laying. Fourth group of eight non laying hens was also used in this study. Blood samples from wing vein were collected from all hens at a fixed time around nine oclock before administration of the hormones to avoid diurinal variation of thyroid hormone level in blood (SARDAVSKY and BENSADOUN, 1971).

According to the time relation to egg laying, the birds were given orally a mixture of 50 ug L-thyroxine (T_4) and 5 ug L-triiodothyronine (T_3) (Gloxo). The horomones were included in cocked starch gell suspension and introduced into the crop by a rubber stomach tube. The same doses of T_4 and T_3 were given to the groups of non laying hens.

Other two samples were then obtained from all birds after 4 and 5 hours from administration of the hormones. This timing was selected to represent post-resorptive stage. The serum samples were collected and kept frozen at -20°C.

Quantitative determination of T_4 and T_3 was accomplished by enzyme linked immuno-absorbant assay (Elisa) according to WOOD (1980). Serum thyrotrophic hormone (TSH) in chicken was determined by radioimmunoassay according to HERSHMAN and PITTMAN (1971).

Computation of biological half-life of hormones were done.

RESULTS

The results obtained from table (1) revealed that, at egg laying time, T_4 level in serum was relatively low (39.9 ng/ml) and lowest at 12 h after egg laying (12.0 ng/ml). It reached its maximal level at 20 h after egg laying (205.1 ng/ml). In case of non-aying hens, serum T_4 level was 45.4 ng/ml. T_3 level in serum did not show significant variation during all stages of egg laving cycle. Significantly high level of serum T_3 was observed in case of non laying hens which was 20.7 ng/ml.

Serum TSH level of hens showed cyclic variations during egg laying cycle (Table 1) which correlated inversely with serum T_4 levels. The lowest level of serum TSH (0.39±0.07 u.i.u/ml) was observed at egg laying, while the maximum level was observed a time around 12 h after egg laying (3.94 u.i.u/ml). In case of non-laying hens TSH was low (0.79 u.i.u./ml).

Absorption of T_4 as indicated from 4 h post resorptive stage was very high at 20 h after egg laying and very low at 12 h after laying (Table 2). In non laying hens and in hens at egg laying time, the rate of absorption of T_4 was moderate. In contrast

to this, absorption of T_3 was increased with a high serum level at 4 h after ingestion of hormones in hens at 12 h after egg laying (Table 3). Lower rate of absorption of T_3 were noticed at egg layingtime and at 20 h after egg laying. Maximal absorption of T_3 was observed in non-laying hens (Table 3).

After 5 h from ingestion of hormones, it was found that, serum level of T_4 showed a decrease during the laying cycle except at 12 h from egg laying. this level showed also a mild decrease in non-laying (Table 2). Serum T_3 level at 5 h from ingestion of hormones decreased slightly at egg laying and obviously at 20 h it was not different from its level at 4 h. The biological half life ($t_{1/2}$) was long in hens 20 h from egg laying (103.3 m), while it was shorter at egg laying (26.4 m) and infinite in hens after 12 h from egg laying. In non-laying hens $t_{1/2}$ of T_4 was very long (702.8 m). The rate of disappearance of T_3 from the circulation of laying hens was more rapid at 12 h after egg laying with $t_{1/2}$ 31.5 m. The $t_{1/2}$ of T_3 was 44.8 m at time of egg laying. In case of hens after 20 h from laying, the $t_{1/2}$ of T_3 was infinite (Table 4). In non-laying hens the $t_{1/2}$ of T_3 was 54.5 m.

Table (1): The level of serum T_4 and T_3 and TSH in laying and non-laying Fayoumi chickens.

Hormones	Laying hens			non-laying hens
	Time after egg laying (hour)			
	0	12	20	
T_4 (ng/ml)	39.9 ±10.0	12.0[a] ±3.5	205.1* ±45.8	45.4[b] ±6.8
T_3 (ng/ml)	1.8[a] ±0.1	2.2[a] ±0.5	2.2[a] ±0.2	20.7[b] ±5.1
TSH (ng/ml)	0.39[a] ±0.07	3.94* ±0.56	1.10 ±0.40	0.79 ±0.04

± Standard error

* Significantly higher than other group in the same raw at $P < 0.01$.

a) The lowest level recorded.

b) Significantly higher than a in the same raw at $P < 0.05$.

Table (2): Rate of clearance of T_4 from serum after ingestion of exogenous T_4 and T_3 by Fayoumi laying and non-laying hens(ng/ml).

Reproductive state	Time after ingestion of T_4 and T_3		
	Basal level	T_4	T_3
Laying hens Time after egg laying			
0 h	39.9 ± 10.0	245.3 ± 28.6[a]	50.9 ± 9 .3
12 h	12.0 ± 0.35	56.4 ± 2.1[a]	60.5 ± 9 .2
20 h	205.1 ± 45.8	539.2 ± 15.2*	359.9 ± 17.1*
non-laying	45.1 ± 6.8	171.1 ± 22.1*	161.3 ± 51.4

± Standard error

* Significantly higher than other groups at $P < 0.01$.

a Significantly different from other at $P < 0.01$.

Table (3): Rate of clearance of T_3 from serum after ingestion of exogenous T_4 and T_3 by Fayoumi laying and non laying hens.

Reproductive state	Time after ingestion of T_4 and T_3		
	Basal level	4 h	5 h
Laying hens Time after egg laying			
0 h	1.8 ± 0.1	4.3 ± 0.2[a]	1.7 ± 0.5
12 h	2.2 ± 0.5	23.6 ± 3.6[a]	6.3 ± 1.2[a]
20 h	2.2 + 0.2	3.4 ± 0.4	3.5 ± 0.3
Non-laying	20.7 ± 5.1	53.6 ± 12.5[a*]	25.6 ± 4.5*

± Standard error

* Significantly higher than laying hens at $P < 0.01$

a Significantly different from basal level at $P < 0.01$

Table (4): Biological half-life ($t_{\frac{1}{2}}$) of T_4 and T_3 in laying and non-laying Fayoumi hens.

Reproductive state	Biological half-life (minutes)	
	T_4	T_3
Laying hens		
Time after laying		
0 h	26.4	44.8
12 h	∝	31.5
20 h	702.8	54.5

DISCUSSION

The present finding revelaed that the thyroid gland of Fayoumi hens exhibited cyclic variations in their activity as correlated with egg laying. Disappearance of T_4 and T_3 from circulation was also correlated with reproductive state of hens. At egg laying time serum T_4 level was relatively low and lowest at 12 h after egg laying, while it increased maximally at 20 h after egg laying. T_3 levels in serum did not show significant variations during all stages of egg layin cycle. In non-laying hens, serum T_4 level was significantly less than that observed at the time of 20 h after egg laying but higher than that observed at 12 h after egg laying. These findings are inagreement with those obtained by AWAD (1979) and SOLIMAN et al. (1980).

Serum TSH level of Fayoumi hens also showed cyclic variations during the egg laying cycle, which correlated inversely with T_4 level. The interaction between TSH and thyroid hormones appears clearly at the stage 12 h and 20 h after egg laying. It was noticed that at 12 h serum T_4 was lowest and T_3 not changed. At this time TSH level was highest. This increased secretion of TSH resulted in the subsequant high serum T_4 at 20 h after egg laying. It can appear clearly that T_4 rather than T_3 can actively play a role in the control of secretion of TSH in chicken. The results of MELLEN and WENTWORTH (1959) indicated that T_4 was more potent than T_3 in reducing TSH secretion in fowl. They also found that, the dose of T_4 which blocked TSH from the pituitaries was smaller than that required by T_3.

In non-laying hens, the amount of T_3 increased about 11 folds that observed in laying hens at all stages of egg laying cycle. Previous investigations revealed that cessation of egg production and molting were always accompanied with significant increase in T_3 level in molting hens (SZELENYLE et al., 1985). Further study showed that injection of T_4 to hens, the egg production remained constant but injection of T_3 decreased egg production (VERHEYEN et al., 1986).

Absorption of T_4 as indicated from 4 h post resporptive stage was very high at 20 h and very low at 12 h after egg laying. In non-laying hens and at egg laying time

their rate of absorption of T_4 was moderate. In contrast to this was find that absorption of T_3 was increased with a high serum level at 4 h after ingestion of hormones in hens at 12 h. Lower rates of absorption of T_3 was observed at 20 h after egg laying. Maximal intake of T_3 was observed in non-laying hens. It appears that at 12 h after egg laying, the hen selectively absorped more T_3 than T_4 from circulation at this stage was blocked completely while T_3 was removed. On contrary at the stage of 20 h after egg laying T_4 absorption was accelerated, while T_3 absorption was delayed and the rate of disappearance of T_4 was fast.

The $t_{1/2}$ of T_4 in laying hens at 20 h after egg laying was almost 4 time longer than that observed at egg laying, at 12 h after egg laying $t_{1/2}$ was not measurable because stagnation of T_4 in circulation. this suggests that turnover of T_4 is more rappid at egg laying, probably to meat additional metabolic activity accompanied with act of laying. The $t_{1/2}$ of T_3 ranged between 31.5 and 44.8 m during early stages of egg laying cycle. In non laying, the $t_{1/2}$ of T_4 was prolonged and $t_{1/2}$ of T_3 was near from one hour. This indicates increased utilization of T_3 rather than T_4 by these birds.

In conclusion, it appears that thyroid gland is closely related with reproductive states of chicken. It is not simply a matter of increased or decreased secretion of its hormone during a certian phase of reproduction during egg laying cycle, but extends to selective absorption or inhibition of absorption of T_4 and T_3 by alimintary tract. It includes also variation in utilization of T_4 and T_3 at certain time in egg laying cycle which different from non-laying hens.

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