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Variability of Serum Thyroxine and Cholesterol in Serum and Egg Yolk with Reproductive State

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THYROXINE (T_4) and cholesterol concentrations in the serum of Hubbard Golden Comet chicken layers were studied at 18, 24, 30 and 36 weeks of age. There was a tendency for an increase in serum (T_4) level (Ug./100 ml.) with advance in age. A sharp increase in (T_4) concentration was obtained at 24 weeks of age, immediately after the onset of egg production. At 30 and 36-weeks-old, the T_4 level increased also, but only moderately, as compared to the first period. Significant differences ($P < 0.01$) due to age in T_4 levels were obtained.

A sharp increase in serum cholesterol concentration at 24 weeks of age occured, followed by a sharp decline at 30 and 36 weeks of age as the rate of egg production increased. These values for serum cholesterol were reflected in egg yolk cholesterol concentration (mg / g. yolk), which had the highest values at 24-weeks-old and declined thereafter. The cholesterol content of eggs (mg./yolk) remained unchanged with age, as a result of increasing the egg yolk weight as the hen advanced in age. A converse relationship between T_4 and cholesterol levels in both serum and egg yolk was obtained. An overall increase in T_4 level coincided with higher rate of egg production.

Key words : Thyroxine, Cholesterol, Blood, Egg.

Cholesterol synthesis increases in hens as they mature, and this is thought to be due to an increase in demand for egg production.

The role of serum cholesterol in the development of atherosclerosis has been a subject of considerable interest and factors affecting serum cholesterol levels in man and in experimental animals have received much attention in recent years.

The effect of age of hen upon egg yolk cholesterol may be expected because it affects the hen's serum cholesterol (Weiss *et*

al., 1967). However, Jones (1969), Turk and Barnett (1971), showed that the cholesterol concentration in the egg yolk does not change with the age of the hen. On the other hand, Spencer *et al.*, (1978) found that cholesterol concentration in eggs increased as the age of hen increased. However, Bair and Marion (1977) reported that egg yolk cholesterol tended to decrease with advance in age.

Weiss and Fisher (1957) found that the correlation between the rate of egg production and serum cholesterol level was not significant ; however, Leveille and Fisher (1958), Wilcox *et al.* (1963) and Weiss *et al.* (1967) reported a significant negative correlation between these two variables.

The level of several blood constituents is quite different in female birds when various reproductive states are compared. The level of these constituents is under the control of circulating hormones that are related to metabolism. It may be expected therefore, that thyroxine (T_4) may have a role in the mechanism of cholesterol metabolism (mobilization) between blood and egg produced, beside the effect on the rate of egg production. Turner *et al.*, (1945) and El-Boushy and Van Albada (1970) noticed an overall decrease in egg production and egg quality due to a lower metabolism of the hen, resulting from reduced T_4 output of thyroid gland that coincided with a reduction in TSH and basal metabolic rate.

It was of interest, then to study T_4 levels and cholesterol concentrations in chicken hen's blood at different ages related to different reproductive states.

Material and Methods

A hundred pullets of Hubbard Golden Comet commercial strain were randomly chosen and moved to laying house at the Abou-Sower Station for egg production belonging to Village Development Project, Ismailia Governorate during the period from March untill July, 1986. Pullets were distributed into 20 cages in deck batteries housed in a windowed house and the lighting program of company exporting the chicks was followed. They were fed *ad libitum* water and a normal commercial laying ration (17 - 18% protein and 2800 Kcal/kg metabolizeable energy).

Twenty blood serum samples (one from each cage) were obtained at four ages ; first before sexual maturity at 18 weeks of age, second after the onset of egg production at 24 weeks of age. A third group of samples was obtained when the highest level of egg production (plateau) was attained at 30 weeks of age, according to Hubbard's guide, and a later group of samples was obtained when the rate of production remains stable, at 36 weeks of age.

The serum samples were transferred to the Department of Animal Production, Faculty of Agriculture, Suez Canal University, Ismailia, for analysis. Serum T_4 concentrations were measured using T_4 Enzyme Immuno Assay Kits (EIA), ENDAB, Immunotech Corp., Cambridge, according to the method described by Chopra (1972).

Serum cholesterol was determined using Bio Merieux kits, Laboratory Reagent and Products, France, using a Spekol Spectrophotometer.

Forty eggs, randomly chosen from eggs laid during each age of sampling (24, 30 and 36 weeks) were used in the determination of egg yolk cholesterol according to the method described by Washburn and Nix (1974). Absorbance was measured at 550 nm on a Spekol Spectrophotometer and was based on duplicate readings. Both egg yolk cholesterol concentration (mg./gm. yolk) and total cholesterol content (mg./yolk) were estimated according to Courchaine *et al.* (1959).

The mean weekly number of eggs produced from each cage and subsequently, per hen, was calculated at the three ages for the 20 cages, each of 5 hens.

Statistical analysis was carried out according to Steel and Torrie (1981).

Results and Discussion

Thyroxine Concentration

Means of serum T_4 concentrations at different reproductive states represented in Table (1) are within the range of values obtained by competitive protein binding (May, *et al.,* 1973) and radioimmuno assay (Newcomer, 1974).

The T_4 concentration level in chicken serum was sharply increased at 24 weeks of age, during the initiation of sexual maturity and onset of egg laying, while the highest values of T_4 concentration were obtained at 30 weeks of age when the highest level of egg production was attained (Tables 1 and 2). The high T_4 levels may be due to higher rate of metabolism at this age that requires continuous T_4 production stimulated by TSH. These results are in agreement with those obtained by Gado (1973).

The possible reason for elevation of T_4 values could be the increased binding affinity of serum albumin for T_4, (Grandhi and Brown, 1975). There was significant difference ($P < 0.01$) in serum T_4 concentration due to age.

TABLE 1. Serum thyroxine (T_4) and serum cholesterol concentration of Hubbard layer at different ages (Mean ± S.D.)

Age (weeks)	T_4 (Ug. / 100ml.)	Cholest. (mg./100ml.)
18	4.47 ± 0.76^b	111.4 ± 13.55^b
24	5.06 ± 0.60^a	139.5 ± 15.45^a
30	5.37 ± 0.69^a	104.8 ± 12.66^b
35	5.42 ± 0.66^a	$109.0 \pm 12.67_b$

a, b : means followed by different letter in the same row, are sifnigicantly different.

TABLE 2. Mean egg production, egg weight (gm.) and yolk cholesterol concentration and content at different ages (Mean ± S.D.).

Age (wks)	Weekly egg number/hen	Egg weight (gm)	yolk weight (gm)	Cholesterol	
				Concent. (mg/gm yolk)	Content (mg/yolk)
24	3.71±0.76	50.55±2.51	17.53± 0.75	26.68±1.12	467.66± 26.96
30	6.51±0.31	57.87±2.60	19.62± 0.42	23.88±1.80	468.22± 46.67
36	6.08±0.46	60.25±1.77	20.45± 1.48	21.78±1.21	445.28± 39.16

On the other hand, T_4 continued to increase during the period from age of sexual maturity and onset of egg production untill reaching a plateau, although the level of egg production declined at 36 weeks of age (Table 2). It is clear that the increase in T_4 values at 36 weeks of age occurred at a lower rate of increase with nonsignificant differences in values obtained at 30 weeks of age.

It could be concluded that an overall increase in T_4 concentration coincided with higher rate of egg production. The best known action of thyroid hormones is their ability to stimulate oxygen consumption, which is usually measured as an increase in basal metabolic rate.

Serum Cholesterol Concentration

Serum Cholesterol concentration values during the experimental period (Table 1) had no real trend, as it increased sharply at 24 weeks of age and then declined thereafter, to the lowest level as compared with that at 18 weeks old. There was a significant effect ($P < 0.01$) of age on serum cholesterol levels. The increase of serum cholesterol level at 24 weeks of age may be due to changes in metabolic activity associated with sexual maturity..

The decrease in serum cholesterol concentration during the period of higher egg production capacity (30 and 36 weeks old) may be due to the inverse relationship between plasma cholesterol and egg production level reported by Weiss *et al.,* (1967).

Such a trend of decreasing serum cholesterol as egg production level increased may be due to a cholesterol shift from the blood to the ovarian tissue for egg yolk formation. The magnitude of such a trend appears to be a metabolic phenomenon, because a continuous serum cholesterol supply has to replinish losses due to egg production.

Duncan's test showed that differences in serum cholesterol levels between 30 and 36 weeks of age were nonsignificant. The decrease in serum cholesterol concentration coincided with the decrease in egg yolk cholesterol (Table 2) with advancing age, which is inverse to the result obtained by Marion *et al.* (1960).

Egg Production Parameters

Table (2) clearly shows that weekly egg production, expressed as per hen, increased sharply to the highest level at 30 weeks old and decreased thereafter.

On the other hand, mean egg weight increased continuously as the hen advanced in age. The egg yolk weight followed the same trend as egg weight.

Egg Yolk Cholesterol

The egg yolk cholesterol concentration (mg./g. yolk) decreased gradually with advance in age (Table 2). This result could be attributed to the negative relationship between cholesterol concentration and yolk weight that coincided with egg weight as the hen advanced in age after commencement of egg laying, or was due to a negative relationship between yolk cholesterol level and egg production capacity.

The total egg yolk cholesterol content (mg./yolk) was found to be constant during the first period following sexual maturity untill the plateau of egg production, although the concentration of yolk cholesterol decreased (Table 2). This result may be due to the increase in egg yolk weight (Riad, 1981). During the second period between 30 and 36 weeks old, the cholesterol content of eggs which decreased significantly in spite of the continuous increase in yolk weight could be due to significant decline in cholesterol concentration of eggs.

The age effect on total egg yolk cholesterol content was due to the increased egg size, as the age of the laying hen increases.

Differences due to age in egg yolk cholesterol concentration and content were significant ($P < 0.01$ and $P < 0.05$, respectively).

Washburn and Nix (1974) concluded that differences in egg production may not be related to differences in yolk cholesterol levels.

Conclusion

From these results, it is concluded that both T_4 and cholesterol concentrations in blood serum increased sharply at initiation of egg production, after which, each constituent followed an opposite trend to the other. Also, the gradual decrease in egg yolk

cholesterol concentration and content in eggs may be due to decreasing in serum cholesterol or due to increasing the oxidative reactions as the level of T_4 increased and subsequently the production rate of eggs increased.

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الاختلافات فى مستوى الثيروكسين بالسيرم والكولسترول بالسيرم وصفار البيض تبعا للحالة التناسلية

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تمت دراسة التغيرات فى تركيز الثيروكسين والكولسترول فى سيرم دجاج كومت البياض فى اعمار ١٨ ، ٢٤ ، ٣٠ ، ٣٦ اسبوعا . وقدوجدت زيادة فى مستوى الثيروكسين معبرا عنه (بالميكروجرام/١٠٠ مل) كلما تقدم عمر الدجاجة . وقد كانت الزيادة كبيرة ومعنوية فى مستوى الثيروكسين فى عمر ٢٤ اسبوعا وهو عمر بداية النضج الجنسى مباشرة ثم تبعها انخفاض فى معدل الزيادة فى الاعمار التالية (٣٠ ، ٣٦ اسبوعا) اذا قورنت بمعدل الزيادة فى الفترة الاولى ، كما ان تأثير العمر على مستوى ثيروكسين السيرم كان معنويا .

وكذلك سجلت زيادة كبيرة فى تركيز كولسترول السيرم فى عمر ٢٤ اسبوعا ثم حدث انخفاض فى الاعمار التالية كلما زاد معدل انتاج البيض وقد انعكس تأثير مستوى كولسترول السيرم على تركيز الكولسترول فى صفار البيض معبرا عنه (مجم/جم صفار) حيث وصل اعلاه فى عمر ٢٤ اسبوعا ثم انخفض بعد ذلك ، بينما ظل المحتوى الكلى للبيض من الكولسترول (مجم/صفار) دون تغير مع تقدم الدجاجة فى العمر وذلك نتيجة زيادة وزن الصفار . ومن النتائج الهامة لهذا البحث انه وجدت علاقة عكسية بين مستوى الثيروكسين والكولسترول فى كل من السيرم وصفار البيض كما وجد اتفاق بين الزيادة فى مستوى الثيروكسين والمعدل العالى لانتاج البيض .