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Changes in thyroid hormones concentrations in chicken blood plasma during fattening

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ABSTRACT

Thyroid hormones concentration changes in blood plasma of 30 male hybrid chickens of the heavy Ross breed were studied during broilers' fattening period. Blood samples were collected in heparinised tubes after decapitation of chickens at 28, 35 and 42 days of age. Blood plasma was separated by centrifugation and concentration of thyroid hormones triiodothyronine (T3) and thyroxin (T4) was determined by the RIA method. Concentration of both hormones gradually increased during the experiment following the broilers' fattening process. However, only the increase of T3 concentration was statistically significant. This rise was related to its involvement in metabolic processes, particularly in processes of bio-oxidation. Different dynamics in concentration changes of investigated hormones may be related to an increase in thyroid gland secretion as well as the peripheral conversion of T4 to the reversible T3 (rT3)

Key words: triiodothyronine (T3), thyroxin (T4), blood plasma, chickens

Introduction

The thyroid gland is an endocrine organ found in all vertebrates. Its hormones triiodothyronine (T3) and thyroxin (T4) are involved in wide range of metabolic activities influencing the growth and development of organisms. The thyroid hormones are primarily involved in energy production by increasing the metabolic rate. This increase in energy production is to the greatest extent manifested as heat production. The importance of these iodine-containing hormones to the growth and development of organisms is most visible in deficient animals that exhibit

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stunted growth and lower productivity. Since the production of broilers in the poultry industry lasts only 42 days, one would expect that thyroid hormones should play a vital role during this process.

The avian thyroid gland is similar in all respects to the mammalian one. The products of its secretion are iodothyronines, the synthesis of which requires circulating iodide and amino acid tyrosine. In the follicular cells of the thyroid gland, molecules of tyrosine are linked by peptide bonds as components of thyreoglobuline, a glycoprotein synthesised by the rough endoplasmatic reticulum of these cells. At the microvillus border of follicular cells and colloid, iodine is bound to the tyrosine-thyroglobulin complex and the product is released into the follicle (LEVY and BERNE, 1993). Avian thyroglobulin is a highly iodised molecule (1.5%) which may contain 50-90 atoms of iodine (STURKIE, 1986). Thyroid hormones T3 and T4 leave the cell through the basement membrane, entering the circulation through the rich capillary network surrounding the cells. The greater parts of hormones are secreted as T4, which by the process of deiodination may revert back to reversible T3 (rT3) (KLANDORF et al., 1978). This process takes place in the peripheral circulation. Secreted hormones circulate almost entirely bound to proteins. Since avian blood plasma does not contain a specific binding globulin, as does mammalian blood (FARER et al., 1961), T3 and T4 are almost entirely bound to plasma prealbumins and albumins (HENINGER and NEWCOMER, 1964). This bond is much weaker than the globulins bond in mammals (STURKIE, 1986). The affinity and capacity of avian blood plasma for T3 are much weaker than for T4 (SINGH et al., 1967; SINGH et al., 1967a).

SHELLBARGER (1955) found almost identical effects of T3 and T4 in birds, which is not the case in mammals. Later investigations by BOBEK et al. (1976) showed that T3 is the main thyroid hormone regulating oxygen consumption, particularly in young chickens. KLANDORF et al. (1981) confirmed that T3 is, in chickens, a metabolically more active substance than T4.

The concentration of thyroid hormones circulating in chicken blood plasma was found to be around 1.2 μl/100 ml (DAVISON, 1975), showing daily variations due to an extremely short half-life and showing T3 to T4 ratio to be 60:40, in favour of T4 (MEHNER and HARTFIEL, 1983). In 1-2-week-old chickens there is a rapid increase of T3 in blood plasma and a successive increase in oxygen consumption. Maximal T3 concentration was achieved at the 2nd day after hatching. The T4 concentration also increased simultaneously, but this increase was expressed more gradually and with lesser intensity (BOBEK et al., 1976).

According to collected data from the literature there is no doubt about the great involvement of thyroid hormones in poultry production processes. However, there is a lack of information about systemic investigations of the subject during the very short period of time covering broilers' production. The aim of this study was to investigate the dynamics of thyroid hormones concentration changes in blood plasma during a fattening period in broilers' production.

Materials and methods

Experiments were carried out on 30 male hybrid chickens of the heavy Ross breed, according to the technology proposals for broiler fattening. During the experiment chickens were given a commercial compound concentrate (Poljoprerada, Hrvatski Leskovac, Croatia), and drinking water *ad libitum*.

During the whole experimental period, temperature and relative humidity, as well as microclimate measurements, were recorded in the hen house and their values were adjusted to be within the limits considered optimal for chickens of this age.

At 28, 35 and 42 days of age, ten birds were sacrificed by decapitation. Blood samples were harvested into heparinized plastic tubes. Within 10 minutes after sampling, the blood plasma was separated by centrifugation at 2,000 r/min., and the plasma concentration of T3 and T4 was recorded by the RIA method, using "BRAMS" Diagnostica GMBH (Berlin, Germany) ready-made commercial kits.

In test tubes whose internal walls were protein covered (T3/T4 antiserum) 50 or 20 μl of blood plasma were introduced for T3 or T4 determination respectively. One ml of antigen marked with radioactive iodine (125I) was added to the mixture and incubated for 2 hours at 17-27 °C. During the incubation period, plasma hormones compete with the marked antigen for binding sites of specific antibodies on the walls of test tubes. High concentrations of T3 and T4 in blood plasma reduce the number of binding sites for marked antigen, and low concentrations act in an opposite direction. After incubation the liquid containing unbound radioactive antigen was extracted from test tubes. Test tubes were left to dry for 10 min. and radioactivity was measured by GM counter (LKB-minigamma counter 1275, Turku, Finland). The level of radioactivity in serum samples was used for determination of antigen concentration in samples. The level of counts per minute is directly proportional to antigen concentration and inversely proportional to the T3 and T4 concentrations

in blood plasma. Measurements of all T3 and T4 samples were provided in triplicate.

The results were evaluated statistically by the S.E. and t test (RENNER, 1970).

Results

The concentration of T3 in 28-day-old chickens varied between 1.2 nmol/l and 2.0 nmol/l, averaging 1.58±0.07 nmol/l and with a coefficient of variability of 15.44% (Fig. 1.). At the age of 35 days plasma concentration of T3 varied between 1.3 nmol/l and 2.3 nmol/l with a mean of 1.85±0.11 nmol/l, coefficient of variability being 18.44%. One week

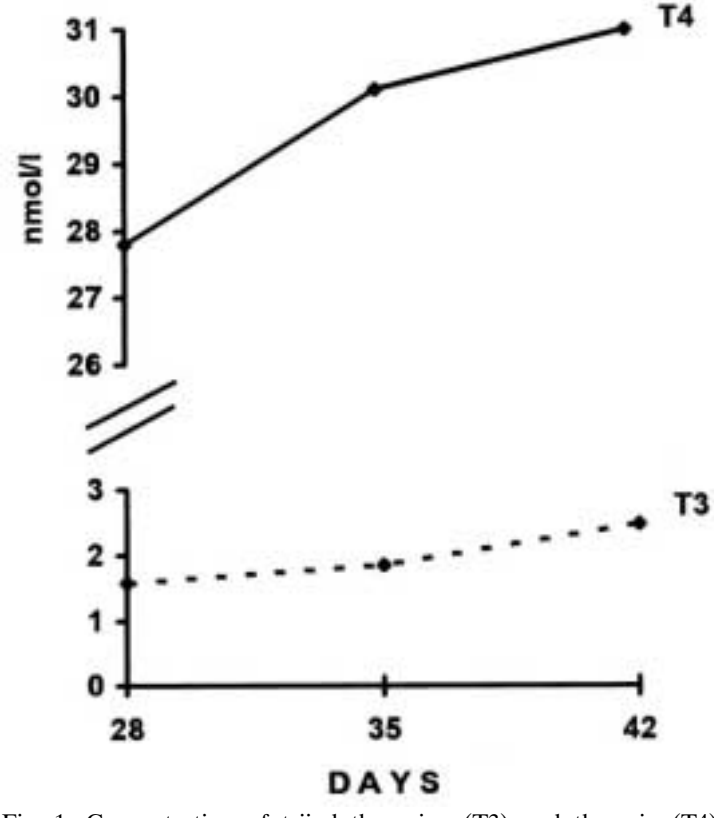

Fig. 1. Concentration of triiodothyronine (T3) and thyroxin (T4) in chicken blood plasma during fattening (nmol/l).

before the end of the fattening period, i.e., at day 42 of life, T3 concentration ranged between 1.8 nmol/l and 3.9 nmol/l, amounting to a mean of 2.48±0.17 nmol/l and with a coefficient of variability of 21.61%. Testing differences between the means showed a highly significant difference ($P<0.001$) only between the first (28-day-old chickens) and the final day (42- day-old chickens) of the experiment.

The concentration of plasma T4 in 28-day-old chickens ranged between 16.00 and 38.00 nmol/l, with a mean of 27.8±2.21 nmol/l and with a coefficient of variability of 25.22% (Fig. 1.). At 35 days of age, values varied between 18.00 and 42.00 nmol/l, averaging 30.11±2.88 nmol/l and a coefficient of variability of 28.71%. In 42-day-old chickens concentration of plasma T4 ranged between 24.00 and 38.00 nmol/l, amounting to a mean of 31.00±1.55 nmol/l and with a coefficient of variability of 15.86%. Differences in the means between the monitored three age groups were not statistically significant.

Discussion

The results indicated that the concentrations of T3 and T4 in chicken blood plasma gradually increased during the entire experimental period. However, in the case of T4 this increase was not statistically significant, whereas the rise of T3 concentration between the beginning and end of the experiment was highly significant ($P<0.001$). Considering the metabolic role of these two hormones in the organism these results should be expected. Namely, because of their involvement in economising on energy in the organism their great importance to the growth and development of young organisms is well known, especially for broiler chickens, which need a great amount of energy for very short and very intensive production period. This explains the rise of T3 concentration in blood plasma observed in this investigation. It is well known that T3 plays a far greater role in bio-oxidation processes in cells than does T4 (BOBEK et al., 1976). The aim of this experiment and subsequent procedures were set out in accordance with this fact. Young chickens switch from the poikilothermic to homeothermic status at the age of four weeks, when they are able to maintain their body temperature by means of their own metabolic processes. Furthermore, at this stage of development chickens begin to accumulate enormous amounts of muscle. This was the reason for monitoring plasma thyroid hormones concentration in this study at day 28 of the chickens' life and at day 42, which is one week before the end of the fattening period. The concentration of thyroid hormones in avian blood plasma, as was mentioned above, depends on numerous factors. The actual concentration of T3 and T4 in blood plasma does not represent the

amount of hormones secreted by the thyroid gland. Rather, it depends on the intensity of peripheral deiodination of T4 to a reverse form of T3 (rT3) also. The specific bonding protein in bird blood plasma, albumins, bind thyroid hormones much weaker than do mammalian thyroglobulins. The affinity and capacity of avian plasma proteins to T3 are much smaller than to T4 (STURKIE, 1986). With this in mind, the results of this study may not reflect the actual activity of chicken thyroid hormones production, but without doubt they do represent the overall processes mentioned above. According to the results of this study one may conclude that the variations in thyroid hormones concentration certainly follow the intensity of production in this life period of birds. The slight rise in T4 concentration during the experimental period is most probably related to the higher production rate of the thyroid gland. The rise in T3 concentration may be a consequence of the same phenomenon as well, but it may also represent, at least in part, a higher conversion of T4 to rT3 in blood plasma. We consider this to be the case, for these rises are responsible for both processes (a particular contribution that was not measured) as a consequence of increased demand for this hormone in chicken organisms during the production period. What is unquestionable is its involvement in different metabolic processes in the organism, particularly in bio-oxidations. Nevertheless, the increase in both thyroid hormones, T3 and T4, during this period of intensive meat production may be related to an increased metabolic rate, especially to energy production, as well as to their involvement in the growth and development of the organism in this specifically life period of young birds.

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STOJEVIĆ, Z., S. MILINKOVIĆ-TUR, K. ĆURČIJA: Kretanje koncentracije hormona štitaste žlijezde u krvnoj plazmi pilića tijekom tova. Vet. arhiv 70, 31-37, 2000.

SAŽETAK

Na pilićima pasmine Ross istraženo je kretanje koncentracije hormona štitaste žlijezde trijodtironina(T3) i tiroksina (T4) u krvnoj plazmi tijekom tova. Za pokus je odabrano 30 muških pilića. Krv za analizu uzimana je 28., 35. i 42. dan starosti netom nakon dekapitacije uz upotrebu heparina kao antikoagulansa. U izdvojenoj krvnoj plazmi određena je koncentracija hormona RIA metodom. Rezultati pokusa pokazali su kako koncentracija oba hormona u krvnoj plazmi raste tijekom pokusnog razdoblja, ali je taj porast statistički značajan samo za T3. Dobiveni rezultati ukazuju kako koncentracija istraživanih pokazatelja prati tijek tova. Značajniji porast koncentarcije trijodtironina u krvnoj plazmi pilića dovodi se u vezu s njegovom značajnijom ulogom u metabolizmu, osobito u procesima biooksidacije. Nadalje se pretpostavlja kako porast istraživanih hormona pokazuje i veću aktivnost štitaste žlijezde u periodu tova. Pri tome koncentracija T4 predstavlja isključivo odraz aktivnosti štitaste žlijezde, dok koncentracija T3 može ovisiti o aktivnosti žlijezde, ali i konvertiranju T4 u T3 u cirkulaciji.

Ključne riječi: trijodtironin (T3), tiroksin (T4), krvna plazma, pile