Effect of temperature stress on the levels of glycogen in muscles and c 3,5-AMP in the muscles and adipose tissue of hens

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The effect of a temperature of 40°C on the levels of glycogen in muscles and c 3,5-AMP in muscles and adipose tissue was studied on two groups of 10 sexually immature hens per group. Putting the birds in a high temperature medium for 150 min. induces a stress reaction: the levels of ACTH and free fatty acids in blood go up. A decrease in the level of muscle glycogen was noticed, while the values for c 3,5-AMP in muscles and adipose tissue were found to increase.

Auswirkungen des Temperaturstresses auf den Gehalt an Glykogen in den Muskeln und an z 3,5,-AMP in den Muskeln und im Fettgewebe von Hühnern

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Bei zwei Gruppen von je 10 geschlechtsunreifen Hühnern wurden die Auswirkungen einer Temperatur von 40°C auf den Gehalt an Glykogen in den Muskeln und an z 3,5,-AMP in den Muskeln und im Fettgewebe untersucht. Die Unterbringung der Hühner in einer Umwelt mit hoher Temperatur für eine Zeitdauer von 150 Minuten ruft eine Stressreaktion hervor - es tritt eine Erhöhung des Gehaltes an AKTH und an freien Fettsäuren im Blut ein. Es wird eine Senkung des Glykogengehaltes in den Muskeln und eine Erhöhung der z 3,5,-AMP-Werte in den Muskeln und im Fettgewebe beobachtet.

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Influence du stress, provoqué par la température, sur le taux de glycogène dans les muscles et de c 3,5,-AMP dans les muscles et le tissu gras de poules

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On a étudié l'influence d'une température de 40°C sur le taux de glycogène dans les muscles et de c 3,5,-AMP dans les muscles et le tissu gras de deux groupes, chacun de 10 poules sexuellement non mûries. Le séjour des oiseaux dans un milieu à une température élevée pendant 150 minutes provoquait une réaction de stress - le taux d'ACTH et d'acides gras libres dans le sang augmentait. On a observé une baisse du taux de glycogène dans les muscles tandis que le taux de c 3,5,-AMP dans les muscles et le tissu gras augmentait.

Влияние температурного стресса на уровень гликогена в мышцах и ц3,5-АМФ в мышцах и жировой ткани кур.

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На двух группах по 10 недостигших половой зрелости кур исследовано влияние температуры 40°C на уровень гликогена в мышцах и ц 3,5-АМФ в мышцах и жировой ткани. Пребывание птиц в среде высокой температуры в течение 150 минут вызывает реакцию стресса - количества АКТГ и свободных жирных кислот в крови повышаются. Отмечено понижение уровня гликогена в мышцах, тогда, как значения ц 3,5-АМФ в мышцах и жирвой ткани повысились.

Effect of temperature stress on the levels of glycogen and c 3,5-AMP in the muscles and adipose tissue of hens

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In industrial raising of hens, the increase of environmental temperature leads to serious disturbances of their homeostasae. According to Delje (4) with the reaction of stress is ensured energy for the increased needs of the organism, and its adaption to the new conditions.

Mitkov et al (3) find that in stress condition, the quantity of glycogen in the muscles of birds is decreased. Sadhu and Chaudhuri (22) establish that sharp increase of temperature of the environment increases the activity of the process of glycogenolyses in the liver. The investigations of a number of authors (1)(13) in birds, similarly to mammals, the reaction of stress is accompanied with the increase of ACTH, adrenalin, and glucocorticosteroids in the blood. The increased content of these hormones in the organism boosts the degradation of the triglycerides to free fatty acids (FFA)(5)(18), and activate muscle and liver phosphorolases, which catalize the degradation of the glycogen to glucoso-1-phosphate or glucose (27). As the investigations of Sutherland show (25)(26) one of the basic mediators of the hormonal activity of the cell is the cyclic 3,5-adenosin monophosphate (c AMP), which is formed in the cell as a result of the stimulating action of some hormones on the adenylatecyclase.

The scope of the present investigation is to follow the development of the stress reaction obtained as a result of the impact of high temperature in hens, and to enlighten the interconnection between the glycogen content in muscles and the concentration of c AMP in muscles and fatty tissue.

Material and Methodics

The experiment was made with 40 hens of the White Leghorn breed of 17 weeks of age, and with a mean body weight of 1370 to 1400 gr. Before the experiment was started all birds were put under equal conditions of feeding and environment.

The investigations were made in a thermal chamber with constant light, temperature control and control of humidity and air velocity. The birds were devided in two groups, each of 20 hens, equalized in background, age and liveweight.

The first group was placed under constant temperature of $17^{\circ} \pm 1^{\circ}C$ and served as control.

The second group was placed in the chamber for 150 minutes under a temperature of $40^{\circ}C \pm 1^{\circ}C$, humidity 70 - 80% and air velocity of 9 - 15 m/min.

Twelve hours before the experiment and during the experiment the birds were deprived of feed but had free access to water.

The samples were studied and were taken in situ following the the scheme:

- before the experiment from 10 birds of the group
- on the 150th minute from the rest of the birds.

The blood samples were obtained by puncture in the left heart chamber, and the tissue samples from m.pectoralis and subskin fatty tissue by biopsy, and immediately after were cooled to $0^{\circ}C$.

In the taken samples was investigated the quantity of the free fatty acids (FFA) after the method of Itaya and Vi (15), the quantity of adenocorticotrope hormone (ACTH), radiologically by way of a kit from the company "Amersham", while the tissue samples were first extracted with alcohol after the method of Amersham (7). The glycogen quantity

in the muscle tissue was determined after the method of Seifter et al (20). All obtained results were treated for probability after Student.

Results and Discussion

On fig.1 is given the change in the ACTH in the plasma of hens, submitted for 150 minutes to the impact of temperature of 40°C. The increase of the environment temperature, inflicts a reliable ($p < 0,05$) increase of ACTH. On the 15oth minute, its level in the test group exceeds with about 30 Picograms/ml that of the control. The value of this increase is not absolute, since for the used by us method, for standard was taken pig.ACTH. Some preliminary studies (unpublished results) show that the level of ACTH established after this method, as well as the level of some other indices characterizing the stress reaction (differential blood picture, FFA) change monodirectionaly with different stress impacts. Inspite of the fact that ACTH in birds is not as yet separated and identified chemically (Madjarov 2) the obtained results give ground to accept that it is similar to the hormone secreted by the mammalians, which is proved by the stimulating effect of pig and beef ACTH injected to birds(9)(12). The change in the quantity of ACTH show that with increased environmental temperature leads to the development of a stress reaction with the participation of the hypothalame-pituitary system (14)(21) and others.

For producing a stress reaction in the test group of birds we could judge by the change of FFA in plasma (table 1) and the glycogen quantity in the muscles (table 2). These results confirm the data obtained by some autors with different stress impacts (3)(8) and others. After Celje (4) with the development of a stress reaction, in the organism sharply increase the needs for energy, necessary for its adaption to the newly created conditions.

One of the mediators of the hormonal action in the cell is the cAMP. On the 150th minute from the begining of the temperature action, the quantity of cAMP in the plasma increases

FIG.1 ACTH in plasma

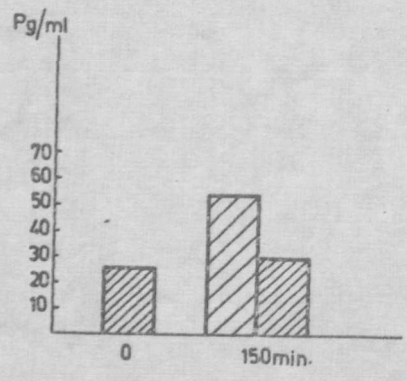

FIG. 2 Adenosine 3,5'-cyclic Monophosphate in plasma

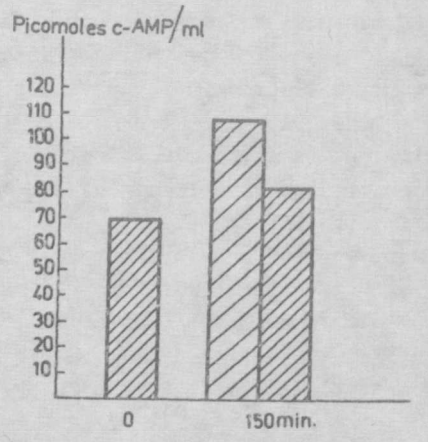

FIG. 3 Adenosine 3',5'-cyclic Monophosphate in pectoralis muscle

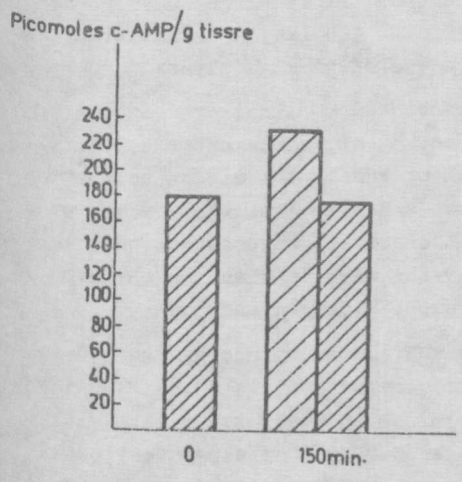

FIG. 4 Adenosine 3',5'- cyclic Monophosphate in adipose tissue

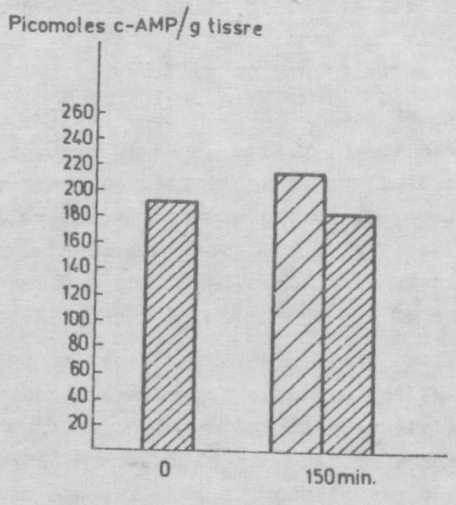

Table 1.

Effect of heat on plasma FFA of chickens 17 weeks of age.

Temperature (°C)	Number of birds/gr.	Minutes of exposure	
		0	150
17°C ± 1°C (control)	(10)	* 335,33 ± 35	352,46 ± 12
40°C ± 1°C (Treatment)	(10)	335,33 ± 35	632 ± 15**

* Mean FFA Level (micro equivalent pex liter) ± s.e.

** Significant differences between control and heat exposed group, $P < 0,01$.

Table 2.

Effect of heat on glycogen content of pectoralis muscle of chickens 17 weeks of age.

Temperature (°C)	Number of birds/gr.	Minutes of exposure	
		0	150
17°C ± 1°C (control)	(10)	† 562,5 ± 36	524,3 ± 28
40°C ± 1°C (Treatment)	(10)	562,5 ± 36	423 ± 62*

† Mean Glycogen Conten of pectoralis muscle (mg% ± s.e).

* Significant differences between control and heat exposed group, $P < 0,05$

from 70 Picemol/ml to 108 Picemol/ml, while in the control group the values do not change (fig.2). Simultaneously with the increase of cAMP in the plasma is established a reliable increase of its content in the muscle tissue ($p < 0,05$)(fig.3) and in the fatty tissue ($p < 0,05$)(fig.4).

According to Sutherland (24), cAMP is activated in the cell by the adenylciclase, which is a basic mediator of the hormonal action. In his studies Fain (10)(11) establishes, that in the fatty tissues cAMP activates the protein kinase which turns nonactive lypase into active and in this manner is stimulated the degradation of the triglycerides down to FFA and glycerol. In the muscle tissue under the influence of cAMP (19)(24) is stimulated the phosphorilase activity and in this way is speeded the process of glycogenolyses.

As the studies of many authors ehibit (16)(23) and others the adrenalin increases the contents of FFA in the plasma, 5 to 10 minutes after injecting it, while after Renold (17) the injection of glucocorticosteroids increases the level of FFA by the direct activation of adenylciclase, while the glucocorticosteroids influence and stimulate the process of lypolyses by activating the synthesis of adenylciclase. Tzahaev (6) demonstrate that in birds as it is in mammalians, ACTH has a direct action by the adenylciclase on the cAMP in the process of the synthesis of corticosteron in the super kidney gland.

It is clear then, that in a stress reaction for ensuring the necessary energy related to the adaption of the birds to the changed conditions of the environment is stimulated the catabolism of glycogen in the muscles and of the triglycerides in the fatty tissue with the direct impact of cAMP. To what extend the activation of cAMP in the separate tissues is due to the direct impact of ACTH or some other factors, we beleive will demonstrate our further studies.

Literature

1.Danilova A.K.,1975 Veterinaria, 2, 27
2.Madjarov U.H.,1978 Stress in domestic animals. Dissertation,Sofia p.248
3.Mitkov S. et al, 1974 Jivotnovudni Nauki,11,p.91
4.Celje G.,1977 Novoe o Gormonah i Mechanisme ich Deistvie, 27
5.Faltas A.,Nestorov N.,1978 Meat Indutry Bulletin,3,10, Sofia
6.Tzachaev G.A.,1976 Voprosi sravnit.i Vosrostna Endocrinelegia,Mosclas,Vilnus
7.Amersham, The Radiochemical Centre, 1976.The cyclic GMP RIA(Product information) 28 p.
8.Braganza A.F.,Peterson R.A. and Cenedella R.J.,1973 Poultry Science 52, 58
9.DeRoos R.,1960 Endocrinology, 67
10.Fain J.N.,1973 Pharmacol.Rev.25,67
11.Fain J.N.,Pointur R.H., and Ward W.E.,1972, J.Biol.Chem.,247,6866
12.Frankel A.I.,1970, Poultry Science 49, 4
13.Freeman B .M.,and Manning C.C.,1975 Br.Poultry Science 16,121
14.Ganong W.F.,1963 The Central Nervous System and the synthesis and release of adrenocorticotropic hormone,in Advances in Neuroendocrinology A.V.Nalbandov, ed.U.,Illinois Press,Urbana
15.Itaya K.,and Vi M.,1965, J.Lipid Res.,6
16.Paoletti R.,Smith R.L.,Maikel R.P.,and Brodie B.B.,1961,Biochem.Biophys.Res.Comm.,5,424
17.Renold A.E.,1960,Recent Progr.Hormone Res.,16,493
18.Rizack M.A.,1961, J.Biol.Chem.236,657
19.Robinson G.A.,Butcher R.W. and Sutherland E.W.,1971,Cyclic AMP,pp 255-256Ac.Press N.Y.
20.Seifter S.,Seymour S.,Novic B,and Muntwyler E.,1950 Arch.Biochem.,25,191
21.Selye H.,1950 The physiology and Pathology of expesure to Stress,Acta Inc.,Montreal
22.Sadhu D.P.,and Chaudhuri S.,1961,Comp.Biochem.and Physiol.,4,72

23.Smith R.L.,Paoletti R., and Brodie B.B.,1962,Biochem.J.,84,51
24.Sutherland E.W.,1970, J.Am.Med.Assoc.,214,1281
25.Sutherland E.W., and Robinson G.A.,1966,Pharmac.Rev.,18,145
26.Sutherland E.W., Oye I., and Butcher R.W.,1965, Recent Progress in Hormone Research pp 623?Academic Press, New York
27.Sutherland E.W., and Rall T.W., 1960, Pharmac.Rev. 12,265