DISTRIBUTION OF RADIOACTIVE THIAMINE IN THE TISSUES OF ANIMALS IN EXHAUSTION OF THE ORGANISM AND WITH RESTORATION OF ORIGINAL WEIGHT

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A number of investigators [1, 3, 4] have studied in detail the process of exhaustion of the organism as a result of starvation. The process of restoration of the original state of the organism on termination of starvation has however been comparatively little studied. Biochemical investigations by various authors indicate that disturbances in metabolism during starvation are deep and varied. In order to restore the organism and establish normal metabolism, apart from making good the material losses, it is necessary to normalize the vitally important systems of the organism which contribute to normalization of metabolism.

In the literature there are indications that thiamine stimulates restorative processes following starvation. In this connection there arises the question of how thiamine is distributed in the animal tissues upon exhaustion due to starvation and with subsequent restoration of a normal state. The experiments were conducted on rabbits. We first of all established in 12 healthy adult animals, the distribution in different tissues and organs of thiamine containing radioactive sulfur (S^{35}); sampling being conducted 2, 6, and 24 hours after subcutaneous introduction of the preparation in the animals, at a rate of 14,000 to 15,000 impulses per 1 g body weight. Since the results of the investigation in four rabbits of each group coincided they are presented in the form of averages in Table 1.

At the same time in these same rabbits the radioactivity of the urine was determined. It was established that within 2 hours the urine of the animals contained 18.2% of the thiamine introduced in the organism, in 6 hours 48%, and in 24 hours 71.5%.

The results of our investigations do not agree with the findings of L. K. Bauman [2] probably due to the differences in dosages of radioactive thiamine employed (in the work of this author the dose was considerably less than 1000 impulses per 1 g body weight). Study of the question of the speed of excretion of radioactive thiamine in the urine is also complicated by the fact that apart from thiamine, its sulfur-containing derivatives [5] may also be excreted in the urine, the process of formation of these derivatives and its dependence on various factors has not been adequately studied. The question as to the form in which thiamine accumulates in the tissues also requires clarification.

In order to study the distribution of radioactive thiamine in the tissues upon exhaustion and with restoration of the organism, experiments were conducted on 25 rabbits. The animals were divided into 5 groups, 5 rabbits in each, each group of uniform weight and age.

TABLE 1

Distribution of S^{35} in Rabbit Tissues and Organs in Relation to Times of Investigation After Introduction of Marked Thiamine

Tissues and organs investigated	Indices in % of introduced activity per 1 g tissue after		
	2 hours	6 hours	24 hours
blood	63.8	24.3	17.2
muscle	8.6	19.0	15.3
liver	667.9	521.4	154.7
lungs	95.4	117.5	86.3
bone marrow	72.4	98.6	91.1
heart	122.5	196.8	224.9
kidneys	722.5	517.3	286.5
brain	72.8	105.0	102.8
spleen	112.5	160.3	75.2
bone	11.7	9.9	

At first the animals were kept on the normal food ration. During the experiments they were in identical cages. The first group was composed of normal animals. The rabbits of the second group were starved until a state of agony was reached. The other three groups of animals were at first starved until they showed a loss of one third of the initial body weight; then the rabbits of the third group were fattened until the original body weight was restored and the rabbits of the fourth and fifth groups were fattened for two weeks and one month respectively, after the initial body weight had been achieved. In the period of starvation the animals received only water, not exceeding 50 mg/kg a day, and upon fattening they received more than the normal food ration

Using as a basis the results of the above-mentioned experiments and taking into account the published findings [6], we considered it useful to investigate the activity of the tissues in the rabbits 24 hours after administration of marked thiamine.

Therefore 24 hours before the termination of the experiment the rabbits were subcutaneously injected in the region of the right femur with a solution of radioactive thiamine, at a rate of 14,000 to 15,000 impulses per 1 g body weight. The animals were sacrificed by means of an air embolism, dissected, and a number of organs and tissues were extracted and their radioactivity measured. Measure of the activity was performed on a thick layer of tissue according to the technique devised by S. E. Shnol [8]. For this purpose a damp film of tissue (70-80 mg) was removed, carefully pulverized and applied in a uniform layer over the entire surface of the aluminum target (diameter 18 mm), kept in a closed desiccator over water for 10 minutes after which the preparation was placed on a stand situated at the aperture of the surface tube and the number of impulses read off on the apparatus B. We give below the average findings of this investigation (Table 2).

It is clear from Table 2 that the normal rabbits 24 hours after introduction of the marked thiamine showed the greatest activity (in diminishing degree) in the renal tissue, then (to a diminishing degree) in the cardiac, hepatic, cerebral, pulmonary, and muscular tissues, and the least activity in the blood. Upon starvation the activity sharply rose in the hepatic, renal, pulmonary, and muscular tissues, insignificantly in the cerebral and splenetic tissues, and perceptibly fell in the cardiac and bone marrow tissues. After fattening of the rabbits, upon restoration of the initial body weight, the activity of all tissues became considerably less than normal. Later, 2 weeks and 1 month after restoration of the original weight of the animals, fluctuation in activity in the tissues was observed and only some indices tended to approximate normal.

TABLE 2

Distribution of S^{35} in Rabbit Tissues with Starvation and with Subsequent Fattening, 24 Hours After Subcutaneous Introduction of Marked Thiamine (in Percentages of Introduced Activity per 1 g Tissue)

Designation of tissues	Normal	After starvation	After fattening with restoration of body weight after		
			24 hours	2 weeks	1 month
liver	154.7	829.3	85.5	175.3	216.3
kidneys	286.5	451.3	197.4	189.6	222.0
heart	224.9	146.3	148.5	91.0	100.3
brain	102.8	124.8	61.0	54.0	50.0
spleen	95.2	119.2	60.6	51.3	74.3
lungs	86.3	138.1	57.9	50.0	59.0
bone marrow	91.1	70.7	64.1	52.0	55.0
muscles	25.3	56.5	22.5	10.3	21.3
blood	17.2	17.1	6.9	7.0	27.6

If the activity of the tissues of the normal animals is calculated in percentages of the total amount of introduced radioactive thiamine, of all the organs the greatest activity will be seen to appear in liver (6.25%). This is in agreement with the findings in the literature [7] according to which the largest amount of thiamine is accumulated in the liver.

When the activity of the urine in rabbits was investigated 24 hours after introduction of the marked thiamine, it was established that the normal animals excreted during the day on average 71.5% of the radioactive thiamine introduced, and the rabbits exhausted by starvation only 41.7%. The decrease in excretion of radioactive substance by the urine during starvation is possibly connected with the fact that the animals in a state of experimental exhaustion also suffer from vitamin deficienty. Therefore during starvation, thiamine accumulates to a large extent in the rabbit tissues and organs and a smaller amount is excreted by the urine. Using as a basis the findings obtained, one may assert that after exhaustion of the organism due to starvation with subsequent restoration of original body weight due to fattening, complete restoration of the metabolic processes does not take place. Usually with starvation there occur extensive disturbances in metabolism, and also other phenomena which persist for a long time in the organism.

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