

# CHANGES IN THE BUFFER CAPACITY OF THE TISSUES DURING ENDOCRINE DISORDERS AND GROWTH OF TUMORS

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In connection with data in the literature on changes in the acid-base balance in the tissues of malignant tumors [3-6], and also of data indicating the role of endocrine disorders in tumor development [1, 2, 7, 8], we considered that it would be of interest to investigate the changes in the buffer capacity of the tissues in association with such disturbances.

We could find no relevant information in the literature.

## METHOD

Experiments were conducted on white rats, mainly males weighing 250-300 g, and females weighing 200-250 g.

The total number of rats used in the investigation was 66, of which 12 were controls. Twelve underwent adrenalectomy and twelve thyroidectomy; nine were castrated, seven underwent Biskind's operation, nine had an M-1 sarcoma and six a sarcoma 45.

Endocrine disorders were induced by thyroidectomy, adrenalectomy, castration and also by castration followed by transplantation of the ovary to the spleen by Biskind's method.

Tumor formation was induced by means of the subcutaneous inoculation of a suspension of tumor tissue. For this purpose sarcomas of strains M-1 and 45 was used. The rats were sacrificed by decapitation: the adrenalectomized animals after 5-9 days, the thyroidectomized and castrated animals at the same time and also after 2-3 weeks, and those undergoing Biskind's operation were sacrificed 4-6 months after operation. The tumor-bearing animals were sacrificed 2-4 weeks after inoculation.

Weighed samples of tissue were taken from the brain, skeletal muscles, heart muscle, liver, kidneys, spleen, lungs and testicles of the sacrificed animals, and these were ground in a mortar to produce a homogeneous mass, to which was added physiological saline in the proportion of 10 ml solution to 1 g tissue. After standing for one

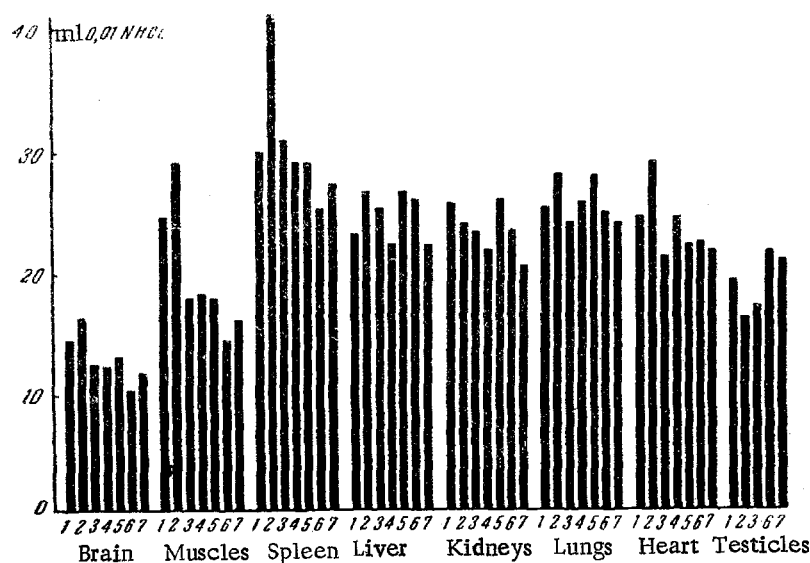


Fig. 1. Changes in the buffer capacity of the tissues (mean values). 1) Control animals; 2) adrenalectomized; 3) thyroidectomized; 4) castrated; 5) animals undergoing Biskind's operation; 6) animals with M-1 sarcoma; 7) animals with sarcoma 45.

hour the extract was separated by centrifugation for 20 minutes at 1500 rpm.

The buffer capacity of the tissue extracts thus obtained was investigated by the method of potentiometric titration with a glass electrode. The LP-5 lamp potentiometer was used. Titration was performed on 10 ml of extract, in which the volume of 0.01 N HCl necessary to produce a shift of one unit was determined. According to Van Slyke, this value is taken as a measure of the buffer capacity in relation to blood. Knowing the degree of dilution of the tissue extracts, the values of the buffer capacity that were found were converted for 100 ml of extract.

## RESULTS

Investigation of the tissue extracts of control rats showed that for each tissue there was a characteristic and definite value for the buffer capacity (Fig. 1). The smallest buffer capacity was found in the brain tissue and the highest in the spleen.

The buffer capacity of the tissues of the lungs and kidneys, i.e., of organs known to play an important part in the control of the reaction of the blood, was equal and on a relatively high level. The buffer capacity of the skeletal muscles was only slightly less than that of these organs.

This definite level of the buffer capacity of the tissues of other organs may possibly be connected with their functional properties. In this respect, the low buffer capacity of the brain tissues, which are known to respond to very small changes in the acid-base balance of the body, is of special interest. It must be pointed out here that an investigation of the buffer capacity of different divisions

of the brain, carried out on a small number of animals, showed the smallest value of the buffer capacity to be in the brain stem.

Investigation of the buffer capacity of the tissues of adrenalectomized animals showed an increase in the buffer capacity of the tissues of the spleen, heart muscle, skeletal muscles, brain and liver. The buffer capacity of the kidney and lung tissues was only slightly changed, and that of the testicles was lowered (Figs. 1 and 2). In the thyroidectomized and castrated males, and also in the castrated females in which the ovary was transplanted into the spleen, a fall in the buffer capacity of the skeletal muscles, and then in the brain and kidney tissues was observed, while the buffer capacity of the remaining tissues was relatively constant (Figs. 1 and 2; 3, 4, and 5). The results obtained demonstrate that endocrine disturbances caused characteristic changes in the buffer capacity of the various tissues.

During the investigation of the buffer capacity of the tissues of the tumor-bearing animals, its value was found to be considerably decreased, especially in the skeletal muscles, and then in the tissues of the brain and also of the spleen and liver (Figs. 1 and 2; 6 and 7). It may be postulated that the sharp fall observed in the buffer capacity of the skeletal muscles was due to the fact that, in the process of its growth, the tumor developing in the body used up the vast reserves of buffer materials in the skeletal muscles, forming about one-half of the mass of the body.

It will be seen from the results described that the changes in the buffer capacity of the tissues of the tumor-bearing animals were similar to those observed after castration and thyroidectomy, but were expressed to a greater degree.

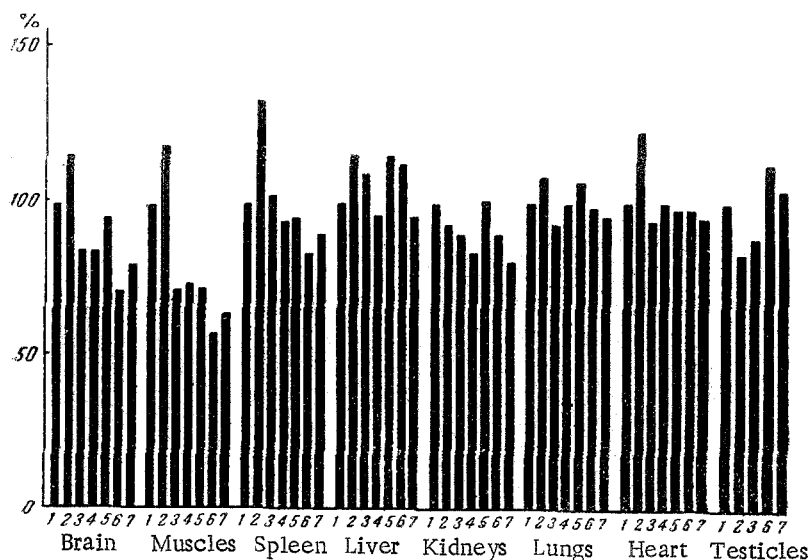


Fig. 2. Changes in the buffer capacity of the tissues of experimental rats as a percentage of the change in the buffer capacity of the tissues of the control rats (mean values). Legend as in Fig. 1.

So far as the active reaction (pH) of the tissues is concerned, this remained constant for the same tissues, both in intact animals, in animals with endocrine disturbances and in tumor-bearing animals.

#### SUMMARY

The authors studied the buffer capacity in the tissues of animals with experimentally induced endocrine disturbances and experiments M-1 and sarcoma 45 by the method of potentiometric titration with the aid of a glass electrode. An increase of the buffer capacity in all the tissues was observed following adrenalectomy. Similar changes were noted in thyroidectomy, castration and tumor growth, i.e., reduction of the buffer capacity, mainly in the skeletal muscle tissue as well as in tissues of the brain, spleen, liver and kidneys. The decrease was even more marked in animals with tumors.

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