

# OXIDO-REDUCTASES IN THE TISSUES IN AN EXPERIMENTAL IRON-DEFICIENCY STATE

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A decrease in succinate dehydrogenase and cytochrome oxidase activity was found histochemically in the tissues of rats with experimental iron-deficiency anemia.

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The view has been expressed [6] that symptoms of iron deficiency in rats reflect a deficiency of cytochrome c and cytochrome oxidase in their tissues. Later work has demonstrated a parallel between the iron content in the body and activity of iron-containing enzymes in animal tissues [1]. A series of experiments [2-5] showed that iron deficiency is accompanied by a decrease in the enzyme activity of cytochrome c, cytochrome oxidase, succinate dehydrogenase, and aconitase in the heart and, to a somewhat lesser degree, in the liver and kidneys of experimental animals.

Because of the small number of investigations which had been undertaken to study the state of oxidoreductases in tissues, especially epithelial tissues, in experimental iron-deficiency states, the present investigation was carried out for this purpose.

## EXPERIMENTAL METHOD

For 6 months, 22 growing female albino rats of the same weight were kept on an artificial iron-deficient diet with a normal content of proteins, fats, carbohydrates, trace elements, and vitamins. Six rats of the same weight acted as controls. At the beginning and in the course of the experiment the animals were weighed, and the hemoglobin concentration in their blood was determined. The animals were sacrificed by decapitation. Two iron-containing enzymes were determined in the liver, heart, stomach, tongue, and mucous membrane of the cheek: succinate dehydrogenase (by the method of Shelton and Schneider) and cytochrome oxidase (by the Nadi reaction). Altogether 1344 histological sections were studied. The level of enzyme activity was estimated from the number of formazan granules formed at places of localization of the enzyme. Microphotometry was carried out with a type MF-4 microphotometer. The results were subjected to statistical analysis.

## EXPERIMENTAL RESULTS

All the experimental rats had developed hypochromic iron-deficiency anemia by the end of the experiment ( $Hb\ 5.48 \pm 1.17\ g\%$ ), while the blood hemoglobin concentration in the control group was  $10.91 \pm 2.4\ g\%$  ( $P < 0.001$ ).

The histochemical investigation showed that succinate dehydrogenase and cytochrome oxidase were present in all the tissues of the anemic animals, but their activity differed from that in the control rats.

In the liver and heart of the experimental animals no decrease in succinate dehydrogenase activity was found, but in the epithelium of the tongue, cheek, and stomach and in the muscular layer of the stomach (Figs. 1, 2) the decrease was significant ( $P < 0.01$ ).

The total of the indices of succinate dehydrogenase activity in all the organs (liver, heart, tongue, cheek, stomach) showed close correlation ( $r = 0.84$ ) with the blood hemoglobin concentration.

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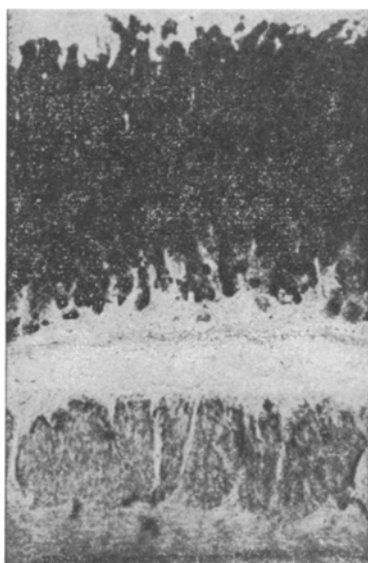


Fig. 1. Stomach of control rat. Reaction for succinate dehydrogenase. Intensive formazan formation indicating high enzyme activity. 140 $\times$ .

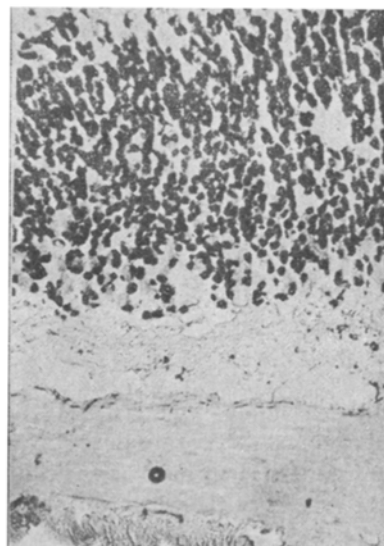


Fig. 2. Stomach of rat with iron deficiency anemia. Reaction for succinate dehydrogenase. Slight formazan formation, indicating weak enzyme activity. 140 $\times$ .

Cytochrome oxidase activity was reduced in all the studied tissues from rats of the experimental group ( $P < 0.01$ ), while the total of the indices of its activity showed only weak correlation ( $r = 0.46$ ) with the hemoglobin concentration.

In the heart and liver, correlation was weak ( $r < 0.6$ ) between the indices of activity of these two enzymes, while in the epithelium of the stomach, tongue, and cheek correlation was close ( $r > 0.7$ ), indicating that the changes were parallel in their course.

It was noted during analysis of the results that the changes in succinate dehydrogenase activity and, in particular, in cytochrome oxidase activity were more marked in epithelial structures.

The effect of deficiency of cell respiration enzymes in rapidly regenerating epithelial tissues is to a large extent known: it usually leads to delay of regeneration and maturation of the cells [8].

The histochemical changes in oxido-reductases observed in these experiments probably develop in the body as a protective reaction aimed at supplying tissue iron for the needs of hematopoiesis. Other experimental evidence has been obtained that enzyme iron can be used in this way for hemoglobin synthesis in iron-deficiency states [7].

#### LITERATURE CITED

1. E. Beutler, *Am. J. Med. Sci.*, **234**, 517 (1957).
2. E. Beutler, M. J. Robson, and E. Bittenwieser, *Ann. Intern. Med.*, **48**, 60 (1958).
3. E. Beutler and M. K. Yen, *J. Lab. Clin. Med.*, **54**, 456 (1959).
4. E. Beutler, *Ann. Rev. Med.*, **12**, 195 (1961).
5. E. M. Beutler, *Scand. J. Haematol.*, **6**, 41 (1965).
6. E. Cohen and C. A. Elvehjem, *J. Biol. Chem.*, **107**, 97 (1934).
7. P. F. Hahn and G. H. Whipple, *Am. J. Med. Sci.*, **191**, 24 (1936).
8. J. Waldenström et al., *Acta Med. Scand. Suppl.* **90**, 380 (1938).