THE DISTRIBUTION OF ALKALINE AND ACID PHOSPHATASE IN THE LIVER OF WHITE RATS DURING IRRADIATION WITH THE RADIOACTIVE ISOTOPE OF IRON Fe^{59}

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There are already several reports in the literature on the influence of x-ray irradiation on the alkaline and acid phosphatase activity of different organs (see the monograph by M. N. Pobedinskii [1]).

M. A. Presnov (see [1]), for instance, studied the alkaline and acid glycerophosphatases of tissues of white rats by a histochemical method, during irradiation with x-rays, and came to the conclusion that general irradiation of the animal leads to increased alkaline and decreased acid phosphatase activity in certain tissues.

Histochemical investigations of the change in the alkaline phosphatase activity of the liver during irradiation of the rabbit's skull with x-rays were carried out by Cali and Verga [3]. These authors found an increase in the glycerophosphatase activity of the liver 24 hours after irradiation. Lelièvre, Betz, et al. [5], studying the changes in the liver of mice after total irradiation with x-rays in large doses, came to the conclusion that the distribution and concentration of acid and alkaline phosphatase in the liver of the irradiated animals showed no change from those of the controls.

Mention must be made of the work of Z. S. Tepikina (1957) [2], who studied by a biochemical method the effect of Fe^{59} on the metabolism in the liver after administration of the radioisotope to animals. The experiments of this author showed in response to internal irradiation, in addition to other changes in the liver, increased activity of the acid phosphatase.

In the accessible literature we were unable to find any histochemical investigations devoted to the study of the phosphatase activity of the organs and tissues in response to internal irradiation by the radioactive isotope Fe^{59}. Such information would, however, be of practical importance.

In the present research, we investigated the activity of the alkaline and acid phosphatases in the liver after internal administration of the radioactive isotope of iron Fe^{59} to animals.

EXPERIMENTAL METHOD

Experiments were carried out on white rats of both sexes, weighing 150-200 g. The experimental animals received 25-45 μC of the radioactive isotope of iron Fe^{59} each day with their food for a predetermined time. Experimental and control rats were killed 6 days after the administration of the isotope began. Altogether 39 rats were used, 21 experimental and 18 control. As soon as the animal had been killed the liver was fixed in 80° alcohol*, and the alkaline and acid phosphatases were determined in frozen and paraffin wax sections by Gomori's [4] method. Sections were incubated in substrates for 3 and 20 hours respectively. The sites of activity of alkaline phosphatase stained a black color, and the acid – brown.

* This part of the work was undertaken by Z. S. Tepikina of the Department of Biochemistry.

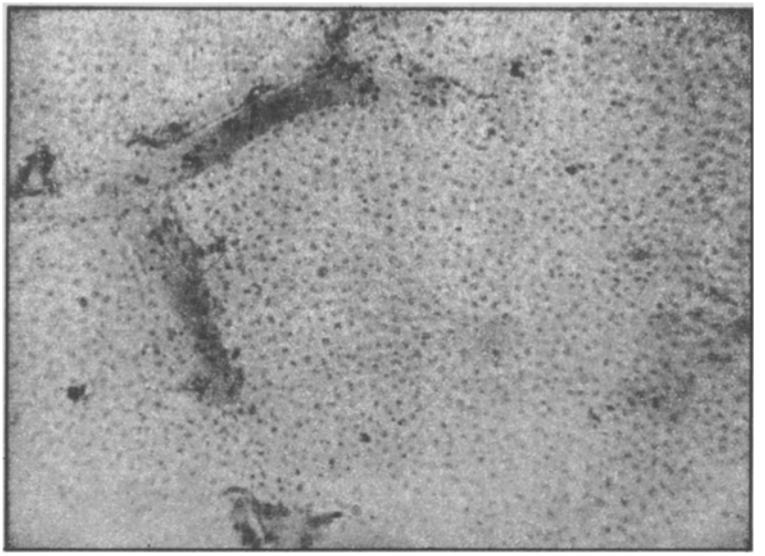

Fig. 1. Distribution of alkaline phosphatase in the liver of control rats. Treated by Gomori's method. Objective 8 ×, ocular 7 ×.

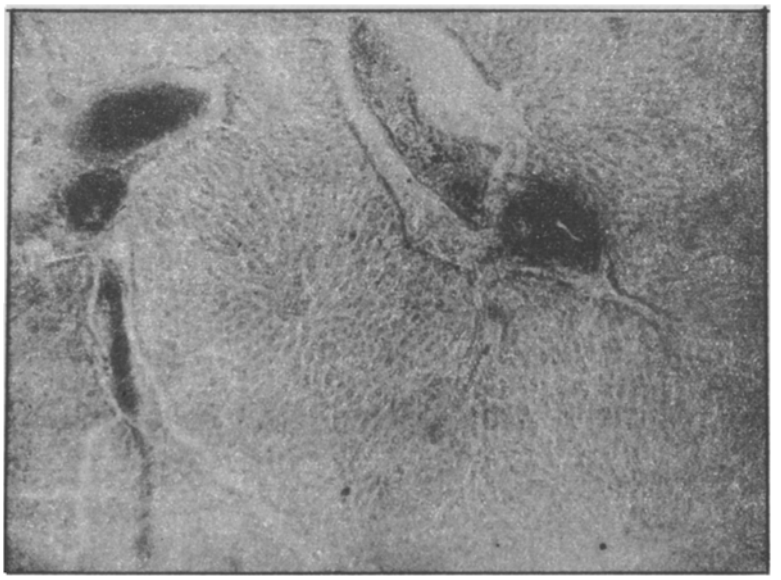

Fig. 2. Alkaline phosphatase in the wall of the interlobular bile ducts. Liver of an irradiated rat. Treated by Gomori's method. Objective 8 ×, ocular 7 ×.

EXPERIMENTAL RESULTS

In the liver cells of the control rats, the enzyme was found in the nuclei, mainly in the nucleoli, although cells were found which did not contain phosphatase. Such cells were distributed mainly around the central veins.

In the lumen of the blood vessels of the liver were found leucocytes with a very high concentration of alkaline phosphatase, and there were more of these cells in the septal veins (Fig. 1). Leucocytes were found in smaller numbers in the blood capillaries, and only solitary ones in the lumen of the central veins. It should be pointed out that the nuclei of the liver cells were more blackened in the areas in which were the largest collections of leucocytes.

High alkaline phosphatase activity was discovered in the walls of the blood capillaries, situated mainly around the periphery of the liver lobules. The enzyme was localized in the nuclei and in the cytoplasm of the endothelial cells. In individual cells of the endothelium of the septal veins, it was found in the form of traces and was localized to the nuclear nucleoli of the endothelial cells.

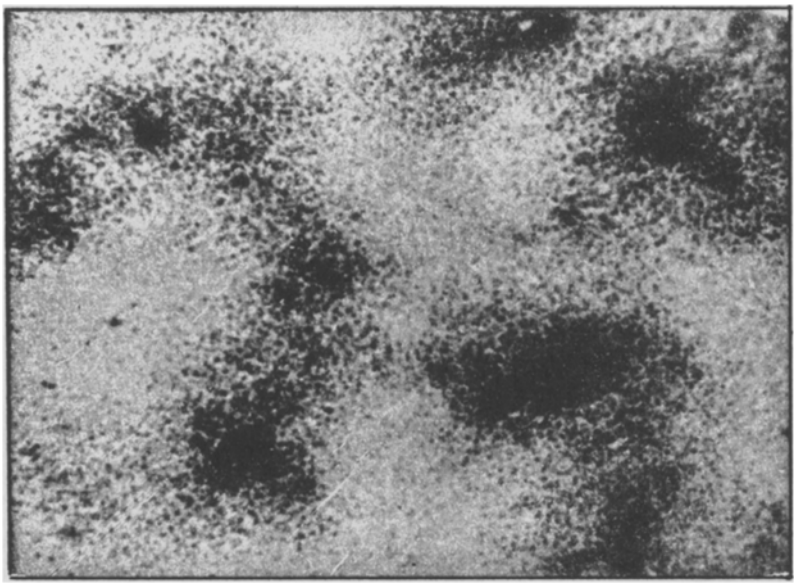

Fig. 3. Distribution of alkaline phosphatase in the liver of an irradiated rat. Treated by Gomori's method. Objective 8 ×, ocular 7 X.

Acid phosphatase was detected in the sections of the liver of the control animals in the nuclei of the liver cells and the endothelium of the blood capillaries, most of the enzyme being present in the nucleoli. Only traces of acid phosphatase were found in the epithelium of the interlobular bile ducts.

After irradiation for 6 days with the radioactive isotope of iron Fe^{59}, the following changes were found in the distribution of the enzymes in the liver. The alkaline phosphatase activity was increased in the nucleoli of the liver cells and the number of leucocytes had increased in the lumen of the blood capillaries with high enzyme activity. At the same time, in the wall of the interlobular bile ducts, alkaline phosphatase was found (Fig. 2). The enzyme was situated in all the cells of the wall, especially in the epithelial cells, and moreover alkaline phosphatase was found in both the nuclei and the cytoplasm of these cells. Sometimes in the films areas of intense blackening could be seen in the wall of the bile ducts, in which there were no visible structures. The liver cells bordering these areas, and also in places collections of leucocytes with very high enzyme activity showed a greatly increased content of the enzyme.

High activity of the enzyme was also found in the interlobular connective tissue of the liver, but its localization could not be determined, since all the cells of this tissue were blackened (Fig. 3).

No changes in the localization of acid phosphatase activity in the liver of the animals after irradiation, by comparison with controls, could be discovered.

The experiments thus showed that the alkaline phosphatase in the liver of control rats was found in the nuclei of the liver cells. The enzyme was localized in high concentration in the leucocytes and the wall of the blood capillaries. Acid phosphatase was found in the nuclei of the liver cells, the endothelium of the blood capillaries and the epithelium of the interlobular bile ducts.

After irradiation for 6 days with the radioisotope of iron Fe^{59}, increased alkaline phosphatase activity and an increase in the number of liver cells containing this enzyme were found.

The localization and activity of acid phosphatase remained visibly unchanged.

SUMMARY

The distribution of the acid and alkaline phosphatase was studied in the liver of white rats irradiated internally with radioactive iron Fe^{59}. For 6 days 25 – 45 μC per day of Fe^{59} was given with food (to experimental animals). The phosphatases were examined by the Gomori's method.

In control rats alkaline phosphatase was revealed in the nuclei of hepatic cells. High concentrations of the enzyme were noted in the leucocytes and the walls of the blood capillaries. The acid phosphatase was found in the nuclei of hepatic cells, endothelium of blood capillaries and in the epithelium of the bile interlobular ducts.

Following a 6-day irradiation with Fe^{59} an increase of the alkaline phosphatase activity along with the rise in the number of hepatic tissue elements containing it was observed. Acid phosphatase localization and its activity remain without any visible changes.

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