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Effect of Reduced Liver and Kidney Catalase Concentrations on Lethality of X Irradiation in Rats.* (22660)

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Hydrogen peroxide, which is toxic to mammals(1), is a product of the X irradiation of water(2). The high percentage of water in the body, coupled with the presence of the hydrogen peroxide-reducing enzyme, catalase, in most living organisms(3) suggests a possible interrelation of X irradiation, hydrogen peroxide, and catalase.

According to Feinstein *et al.*(4), about 75% of the total body catalase in Sprague-Dawley rats is present in the liver and another 7% in the kidneys. Heim *et al.*(5) have reported that a single injection of 1 g of 3-amino-1,2,4-triazole kg of body weight in rats reduces the liver and kidney catalase concentration to about 11% of normal in several hours and that it takes more than 72 hr for the catalase to return to normal levels. It seemed of interest to determine whether reducing the liver and kidney catalase to low levels with this compound would increase the number of deaths in X-irradiated rats.

Materials and methods. Sprague-Dawley rats were used throughout. The 3-amino-1, 2,4-triazole (AT)† was used in concentrations of 50 mg/ml in water. Physiological saline (0.9%) was injected into all control animals. Both solutions were administered intraperitoneally in volumes of 20 ml/kg of body weight 4½ hr before either catalase assays or X irradiation. The results of the X-radiation experiments are shown in Table I. Inasmuch as the catalase-reducing effects of AT were reported for a different strain from that to those used in the experiments reported herein, the finding was checked. The liver catalase was assayed by the perborate method(6) and found to be depressed to 15-40% of that in

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TABLE I. Reduced Liver Catalase and Sensitivity to X Radiation (934 r).

Inj. material and amt inj. per kg rat wt	No. of rats inj. and wt range, g	No. of rats dying during 30-day observation period	Post-irradiation survival time, days
	Exp. I*		
AT, 1 g	12, 359–412	3	11 15 17
Saline (0.9%), 20 ml	12, 360–415	4	11 11 12 13
	Exp. II†		
AT, 1 g	20, 410–560	3	11 7 10
Saline (0.9%), 20 ml	20, 400–570	3	7 8 8

* Dose rate, 55.6 r/min.; target-rat distance, 89 cm.
† Dose rate, 51.4 r/min.; target-rat distance, 105 cm.

the controls.

The X-ray source was a General Electric Maxitron 250 operated at 250 kvp and 30 ma with a 3-mm Al filter and inherent filtration equivalent to 0.1 mm of Al (beryllium window). The hvl was 0.55 mm of Cu. A rotating circular lucite cage‡ (outside radius 17.5 cm) with 8 compartments was used as an exposure box. The cage was essentially the same in design as the circular mouse cage described by Upton *et al.*(7). Calibrations were made with a Victoreen 100-r condenser type ionization chamber, the chamber resting on a support in the cage and the thimble in the position of the center of the rat. The dose in both radiation experiments was 934 r; dose rates and vertical distances from the Victoreen to the level of the X-ray target were slightly different and are indicated in Table I.

Results. The catalase concentration was reduced to about 3% of normal 4½ hr after injection of AT, confirming a similar finding by Heim *et al.*(5) for Long-Evans rats. A check on the reduction of kidney catalase and the long recovery period for liver and kidney catalase also reported by these investigators does not seem necessary. The average value for liver catalase in the saline-injected control rats, 0.89 catalase unit, is very close to the 0.81 previously reported for the same strain (6).

Table I shows mortality data for the X-irradiated rats. In the first experiment, the radiation dose of 934 r resulted in a 30-day LD_{25} for the AT-injected animals and a 30-day LD_{33} for the saline controls. In the second experiment, the same level of radiation gave a 30-day LD_{15} for both groups. The data indicate that a low liver catalase level at the time of irradation does not increase the lethality of X radiation. Any possible role of the blood or blood-producing tissue catalase as a radiation protection agent is not elucidated by these experiments since AT does not reduce the blood catalase level(5) and since the catalase level in hematopoietic tissue was not measured. However, it seems clear that individual and strain differences in the lethal effects of X irradiation cannot be attributed to differences in liver and kidney catalase levels. It should be pointed out that the role of liver and kidney damage in 30-day irradiation mortality is not clear.

Summary. Liver and kidney catalase was markedly reduced in rats by the injection of 3-amino-1,2,4-triazole. X irradiation of these animals did not cause more deaths than in saline-injected control groups. It was concluded that differences in liver and kidney catalase levels cannot account for differences in sensitivity to the lethal effects of X irradiation.

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