Proceedings
of the
Society
for
Experimental Biology and Medicine

VOL. 39. OCTOBER, 1938. No. 1.

SECTION MEETINGS

NEW YORK		
New York Academy of Medicine	October	26, 1938
PEIPING		
Peiping Union Medical College	June	1, 1938
SOUTHERN CALIFORNIA AND PACIFIC COAST		
San Diego, Calif.	June	22, 1938

10068 P

Effect of Roentgen Rays on the Phytopharmacological Reaction of Blood.

DAVID I. MACHT.

From the Pharmacological Research Laboratory, Hynson, Westcott & Dunning, Inc., Baltimore, Md.

Roentgen sickness is a not infrequent occurrence among patients undergoing X-ray therapy. The profoundly toxic reaction of an English setter irradiated for the purpose of sterilization was the starting-point of the present investigation. The question raised was whether a toxic substance, possibly generated by such irradiation, could be detected in the blood of various animals. Inasmuch as toxins which could not be demonstrated by zoöpharmacological methods have been detected by the phytopharmacological test,[1, 2] such a phytopharmacological examination was made of blood specimens obtained before and after exposure of various animals to

[1] Macht, D. I., and Livingston, M. B., *J. Gen. Physiol.*, 1922, **4**, 573.
[2] Macht, D. I., *Science*, 1930, **71**, 302.

X-rays. The method employed has been described in numerous publications.[3, 4] The effect of one percent solutions of whole blood or of blood serum on roots of *Lupinus albus* seedlings, grown under standard conditions of temperature, light, etc., was observed and recorded.

Blood from 10 kinds of animals was studied and this preliminary announcement reports the results obtained in experiments with rats (30), rabbits (25), cats (5), dogs (2), guinea pigs (4), mice (10), pigeons (3), fish (2), frogs (6), and human beings (2). The figures in parentheses indicate the number of experiments performed. The effect of one percent solutions of either whole blood of smaller animals or blood serum of larger animals in normal condition was compared with that of one percent solutions of blood or serum obtained after exposure of the same animals to various doses of X-rays. The physical apparatus used in this investigation through the courtesy and collaboration of Dr. C. F. Burnam of the Howard A. Kelly Hospital was a constant potential electric transformer with water-cooled therapy tubes. The kilovoltage was 264, milliamperes, 30. The X-rays were filtered through a copper plate and an aluminum plate, each one millimeter thick. Animals were irradiated at a distance of 50 cm, dosage per minute being 105r. The dosage used ranged from 200r to 750r and occasionally even to 1000r. In some experiments the effect of small *repeated* doses of X-rays was also studied.

Table I sets forth the clear-cut and striking results obtained. When normal specimens from the various animals were compared phytopharmacologically with those taken after their irradiation, it was found that Roentgen rays rendered the blood more toxic for *Lupinus albus* seedlings. The degree of toxicity varied considerably, depending on the dosage of radiation used. More interesting, however, was the fact that this toxic substance did not usually appear in the blood immediately after irradiation. Some toxicity was detected in blood drawn a few hours after exposure but the greatest amount was usually noted 24 hours after exposure. This finding suggests the gradual formation and liberation of a toxic substance as a result of irradiation of various tissues. The toxemia persisted for 2 or 3 days after which the animals' blood returned to normal unless the X-ray dosage had been very great. Most of the tests were made on lower animals in normal health. Results of clinical studies of patients undergoing X-ray therapy, which are now in progress, will

[3] Macht, D. I., *Protoplasma*, 1936, **27**, 1.

[4] Macht, D. I., *Arch. Derm. and Syphilol.*, 1937, **36**, 1022.

be reported later. The blood of the patient listed in the table, Mrs. Y, with advanced carcinoma of the breast, showed over 50% toxicity the day following her exposure to 300r for therapeutic purposes. In such clinical cases, of course, the phytotoxic reaction may be due in large measure to the products of decomposition elaborated by the malignant growth as the result of irradiation.

TABLE I.

Animal	Dosage r	Normal Phytotoxic Index*	%	Phytotoxic Index* After Irradiation	%
Mouse	250	Whole blood	74	After 24 hr	52
Rat	300	" "	77	" " "	52
Guinea pig	250	Blood serum	76	" " "	56
Kitten	250	" "	71	" " "	54
Rabbit	300	" "	70	" one "	68
"	300	" "	70	" 24 "	55
"	300	" "	70	" 72 "	48
"	300	" "	70	" one week	75
Pigeon	250	Whole blood	63	" 24 hr	47
Dog	300	Blood serum	75	" " "	66
Fish (pike)	500	" "	75	" " "	64
Frog	500	Whole blood	55	" 2½ "	27
"	500	" "	55	" 24 "	23
Mrs. Y. (Carcinoma of breast)	300	Blood serum	68	" " "	32

* Ratio of growth in blood solution to growth in physiological control solution.

Studies are being made on the relative toxicity of blood obtained after irradiation of different regions of the animal body. The possible value of some substances suggested as antidotes for Roentgen sickness as, for instance, Congo red, various vitamins and extracts from *Melanoplus differentialis,* a grasshopper rich in several vitamins,[5] is also being investigated.

Summary. Phytopharmacological experiments on samples of blood obtained from normal animals before and after their exposure, respectively, to various doses of Roentgen rays revealed that they contain a substance which inhibits root growth. This substance may be detected a few hours after irradiation but is found in largest amounts 24 hours later. The effect of irradiation of different parts of the animal body on the toxicity of the blood, the possibly antidotal effect of some chemical compounds and the clinical aspects of the subject in human beings are still under investigation.

[5] Macht, D. I., *Am. J. Physiol.*, 1937, **119**, 268.