

storage life. It is not certain, however, that the anti-oxidant disappears at the same stage of the reaction at all temperatures, and further investigation is required before the part it plays in the whole series of changes can be suggested.

The relationship between these effects and those of normal autoxidation, or the after-effect observed spectroscopically by Mead⁴ with X-irradiated linoleic acid, is still obscure. Qualitatively similar effects have also been shown with 40-kV. X-rays.

This work has been carried out with the co-operation of the Medical Research Council as part of the programme of the Food Investigation Organization of the Department of Scientific and Industrial Research. We are grateful to Mr. J. W. Boag and Mr. D. Moore, of the Radiotherapeutic Research Unit of the Medical Research Council, Hammersmith Hospital, for carrying out the necessary irradiations.

R. S. HANNAN
H. J. SHEPHERD

Low Temperature Station for Research in
Biochemistry and Biophysics,
Cambridge.
Sept. 2.

¹ Hannan, R. S., and Boag, J. W., *Nature*, **169**, 152 (1952).

² Loftus-Hills, G., and Thiel, C. C., *J. Dairy Res.*, **14**, 340 (1946).

³ Schibsted, H., *Indust. Eng. Chem. (Anal. Ed.)*, **4**, 204 (1932).

⁴ Mead, J. F., *Science*, **115**, 470 (1952).

Differences in the Biological Activity of 2 : 3 : 5 : 6-Tetrachloronitrobenzene and its Isomers

In a recent paper¹, differences in the metabolism of 2 : 3 : 5 : 6-tetrachloronitrobenzene and the 2 : 3 : 4 : 5 compound in the rabbit have been described. Preliminary investigations in these laboratories have shown other differences between these compounds.

The 2 : 3 : 5 : 6 symmetrical isomer, formulated as a dust, has been used successfully to control *Botrytis* disease of lettuce² and dry rot of seed potatoes³, and it has been shown to inhibit the sprouting of potatoes^{4,5}.

In our experiments, against normal strains of *Fusarium cæruleum* (Lib.) Sacc. in culture, 2 : 3 : 4 : 5 tetrachloronitrobenzene has inhibited radial growth more than the 2 : 3 : 5 : 6 isomer. Two of the mutant strains produced by McKee, and shown by him to be resistant to the 2 : 3 : 5 : 6 isomer⁶, have been tested, and found to be less resistant to the 2 : 3 : 4 : 5 isomer. Both retained resistance to 2 : 3 : 5 : 6-tetrachloronitrobenzene after five months growth in its absence. In the accompanying table are results from an experiment in which subcultures were grown under the influence of the vapour from 0.01 gm. of the pure isomers deposited centrally in the lids of the Petri dishes.

MEAN INCREASE OF COLONY DIAMETER (MM. PER DAY): MCKEE
STRAIN B

Strain	Tetrachloronitrobenzene isomers		
	None	2 : 3 : 5 : 6	2 : 3 : 4 : 5
Normal	7.0	4.5	3.7
Mutant, resistant	5.3	5.1	3.7

When 1-lb. batches of Craig's Defiance potatoes were each dressed with 2 gm. of a 2 per cent dust of each isomer, and stored in closed tins until untreated controls were sprouting profusely, the following mean sprout weights were obtained :

None	Tetrachloronitrobenzene isomers	
	2 : 3 : 5 : 6	2 : 3 : 4 : 5
26.8 gm.	16.4 gm.	27.9 gm.

With treated potatoes in small clamps, some inhibition of sprouting occurred with seed treated with the 2 : 3 : 4 : 5 isomer, but less than that in clamps treated with the 2 : 3 : 5 : 6 isomer. It is concluded that 2 : 3 : 4 : 5-tetrachloronitrobenzene is a less powerful inhibitor of potato sprouting than is the 2 : 3 : 5 : 6 isomer.

Application of the isomers as 5 per cent dusts to lettuce in boxes resulted in a visible check to growth, which was quickly overcome in the case of the 2 : 3 : 5 : 6 isomer but which persisted in plants treated with the 2 : 3 : 4 : 5 isomer and produced a significant reduction in dry weight of the final crop ($P = 0.001$). It is concluded that both isomers can inhibit the growth of lettuce, but the 2 : 3 : 4 : 5 isomer is a more powerful inhibitor. Preliminary field-tests have shown the 2 : 3 : 4 : 5 isomer to be less effective than the 2 : 3 : 5 : 6 in controlling *Botrytis* disease of lettuce.

The limited examination yet made of 2 : 3 : 4 : 6-tetrachloronitrobenzene suggests it is more active than the other two isomers in inhibiting the growth of both *Fusarium cæruleum* and *Botrytis cinerea* in culture, and the sprouting of potatoes, but may be less inhibitory towards the growth of lettuce.

The investigations are continuing.

M. BROOK

Research Department,
Agricultural and Horticultural Division,
Boots Pure Drug Co., Ltd.,
Lenton Experimental Station,
Nottingham.
June 9.

¹ Bray, H. G., Hybs, Z., Lake, H. J., and Thorpe, W. V., *Biochem. J.* **49**, lxxv (1951).

² Brown, W., and Montgomery, N., *Ann. App. Biol.*, **35**, 161 (1949).

³ Foister, C. E., and Wilson, A. R., *J. Min. Agric.*, **57**, 229 (1950).

⁴ Brown, W., *Ann. App. Biol.*, **34**, 422 (1947).

⁵ Luckwill, L. C., Rep. Agric. Hort. Res. Sta. Bristol, 1948, 124 (1949).

⁶ McKee, R. K., *Nature*, **167**, 611 (1951).

Mode of Action of Agents giving Protection from Radiation

A CONSIDERABLE number of compounds is now known to be capable of protecting animals against X-rays and other radiations. Among the most effective of these are sodium cyanide and sodium azide¹, and thiourea²; alcohols³ and amines⁴ are active at higher concentrations. X-rays degrade polymethacrylic acid in aerated aqueous solutions, and the extent of the reaction could readily be followed by changes in viscosity with a high molecular weight sample of the polymer⁵. Table 1 shows that the degradation is reduced in the presence of substances which are protective agents in biological experiments. Since the compounds were placed in the same order of effectiveness in both tests, it is suggested that similar chemical reactions are involved. Allyl thiourea, which does not appear to have been examined biologically, was found in our work to be a highly effective protective agent.

Since polymethacrylic acid is not degraded by comparable doses of X-rays in the absence of air (see