Correlation of the Absolute Configuration of Phosphorus Thio-acids by Nuclear Magnetic Resonance Spectroscopy

By M. MIKOŁAJCZYK* and M. PARA
(*Institute of Organic Chemistry, Polish Academy of Sciences, Łódź 40, Żwirki 36, Poland*)

and A. EJCHART and J. JURCZAK
(*Institute of Organic Chemistry, Polish Academy of Sciences, Warszawa, Kasprzaka 44/52, Poland*)

Summary The n.m.r. sense of nonequivalence of (—)α-phenylethylamine salts of chiral phosphorus thio-acids has been correlated with their absolute configurations; the (*R*)-configuration is assigned to (—)-*O*-methylmethylphosphonothioic acid and (—)-*O*-ethylmethylphosphonothioic acid.

THE determination of the absolute configuration of (+)-benzylmethylphenyl-n-propylphosphonium bromide as (*S*) by *X*-ray analysis[1] made possible the assignment of absolute configuration to other phosphonium salts, phosphines, and phosphine oxides by chemical correlation.

Two chemical methods[2,3] have been reported for determining the absolute configuration of optically active phosphorus thio-acids, which are essential starting materials for a number of optically active phosphoryl and thiophosphoryl compounds. The former method[2] involves the stereospecific conversion of thio-acids into phosphine oxides of known configuration, and the latter[3] asymmetric reduction of sulphoxides with optically active phosphorus thio-acids.

We report the application of n.m.r. spectroscopy to the correlation of the absolute configuration of phosphorus thioacids. The phosphorus thio-acids (I—IV) form diastereoisomeric dynamic systems with (—)-α-phenylethylamine in nonpolar solvents. The n.m.r. spectra of these systems show an anisochronism of the diastereotopic groups. A similar phenomenon has also been observed recently in the case of chiral carboxylic acids.[4,5]

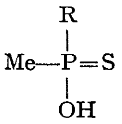
The nonequivalence of the n.m.r. spectra of the diastereoisomeric salts is most readily observed for the methyl group directly bonded to the chiral phosphorus atom. The values of $\Delta\delta$ and the relative positions of the methyl group signals corresponding to the predominant enantiomer of the thio-acids studied are summarised in the Table. The magnitude of nonequivalence observed for the methoxy-group is lower ($\Delta\delta_{\mathrm{MeOP}}$ 1·63 Hz in CCl_4 and 0·92 Hz in $CDCl_3$).

The salts of thio-acids (—)-(III) and (+)-(IV) (Table), in which the chirality of the phosphorus atom is (*R*), exhibit low-field sense of nonequivalence for the methyl resonances. The same sense of nonequivalence is observed for the salts of thio-acids (—)-(I) and (—)-(II). Within one class of compounds the sense of nonequivalence ought to be the same;[6] thus, it seems reasonable to assign the (*R*)-configuration to phosphorus thio-acids (—)-(I) and (—)-(II).†

Correlation of n.m.r. sense of nonequivalence of (—)-α-phenylethylamine salts of phosphorus thio-acids with absolute configuration

Acid	Opt. purity[a]	$\Delta\delta_{\mathrm{MeP}}$ (Hz)	Nonequivalence sense	Absolute configuration
(—)-(I)	78	9·9, CCl_4	low	*R*
	78	7·9, $CDCl_3$		
(—)-(II)	70	12·6, CCl_4	low	*R*
	71	10·5, $CDCl_3$		
(—)-(III)	71	8.8, $CDCl_3$	low	*R*[2]
	70	8·6, C_6H_6		
(+)-(IV)	70	9·2, CCl_4	low	*R*[2]
	74	8·3, $CDCl_3$		
	74	9·9, C_6H_6		

[a] The salts of (—)-α-phenylethylamine and thio-acids of given purity were prepared from optically pure and racemic thio-acids.



$$\mathrm{Me{-}P(R)(=S)OH}$$

(I) R = MeO
(II) R = EtO
(III) R = Pr^{i}O
(IV) R = Ph

The comparison of $\Delta\delta_{\mathrm{MeP}}$ values of (—)-α-phenylethylamine salts of the thio-acid (IV) of different enantiomer contents is of great interest. Whereas the $\Delta\delta_{\mathrm{MeP}}$ value of the salt of the racemic acid was 7·4 Hz, the $\Delta\delta_{\mathrm{MeP}}$ values of the salt enriched with (+)-(IV) and with (—)-(IV) were 9·2 and 2·5 Hz, respectively.

(*Received, March 4th,* 1970; *Com.* 311.

† The results of asymmetric reduction of n-propyl methyl sulphoxide with thio-acids (—)-(I) and (—)-(II) lead to the same conclusion; M. Mikołajczyk and M. Para, unpublished results.

[1] A. F. Peerdeman, J. P. C. Holst, L. Horner, and H. Winkler, *Tetrahedron Letters*, 1965, 811.
[2] H. P. Benschop, G. R. Van den Berg, and H. L. Boter, *Rec. Trav. chim.*, 1968, **87**, 387.
[3] M. Mikołajczyk and M. Para, *Chem. Comm.*, 1969, 1192.
[4] I. P. Guette, L. Lacombe, and A. Horeau, *Compt. rend.*, 1968, **267**, *C*, 166.
[5] A. Ejchart and J. Jurczak, unpublished work.
[6] W. H. Pirkle and S. D. Beare, *J. Amer. Chem. Soc.*, 1968, **90**, 6250; W. H. Pirkle, S. D. Beare, and R. L. Muntz, *ibid.*, 1969, **91**, 4575.