

Resolution and Absolute Configuration of *trans*-Thiolane-3,4-dicarboxylic Acid

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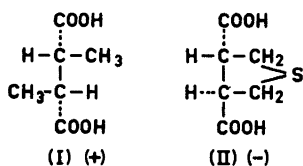
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The allo-isomers of the biologically important biotin contain a thiolane ring, which is fused to an imidazole ring with *trans* configuration at carbons 3 and 4.

The related compound *trans*-thiolane-3,4-dicarboxylic acid was studied and it was found of interest to determine its absolute configuration.

The levorotatory acid is easily obtained *via* the strychnine salt. The dextrorotatory form is more difficult to obtain optically pure but after several recrystallisations of the quinine salt the acid could be brought to maximum activity.

The (-)-thiolane-3,4-dicarboxylic acid could be converted into (+)-2,3-dimethylsuccinic acid by desulfurization with Raney nickel. Some years ago the (R,R)-configuration (I) was deduced for the latter.¹ Hence, the levorotatory thiolane-3,4-dicarboxylic acid possesses the (R,R)-configuration and is represented by (II).



Experimental. All the melting points are uncorrected.

trans-Thiolane-3,4-dicarboxylic acid (II). This acid was prepared by two methods.

The first was that according to Marvel *et al.*,² from tetraethyl ethane-1,1,2,2-tetracarboxylate and bis-chloromethyl sulfide in about 40% yield. A suspension of sodium hydride in oil was used. Instead of isolating the crude diacid by continuous ether extraction, it was found more convenient to extract three times with ethyl acetate.

The second method was that according to Holmquist,³ from diethyl 2,3-bis-bromomethyl succinate and sodium sulfide in about 60% yield.

Both methods gave a mixture of *cis* and *trans* isomers. The conversion of this mixture to pure *trans*-diacid was made by esterification of the *cis-trans* mixture and inversion by sodium methoxide followed by hydrolysis. The method is given by Brown *et al.*⁴

Levorotatory acid. 10.4 g (0.06 mole) racemic acid in 125 ml boiling ethanol was mixed with 9.8 g (0.03 mole) strychnine in 250 ml boiling ethanol. After cooling, 13.8 g salt was obtained which was recrystallised five times from 50% aqueous ethanol (50 ml/g salt); the activity remained constant after three recrystallisations. The acid was liberated and recrystallised three times from acetone-benzene giving plates or flat needles with m.p. 137.5–138°. (Equiv. wt. found 88.4; calc. 88.1. $[\alpha]_D^{25} = -151.4^\circ$ in absolute ethanol). The racemic acid melted at 133–136°, resolidifies and remelts at 140–141°.

Dextrorotatory acid. The first mother liquor of the strychnine salt yielded, after decomposition, 3.15 g acid having $[\alpha]_D^{25} = +114^\circ$. This acid in 50 ml boiling ethanol was mixed with 5.8 g quinine in 125 ml boiling ethanol. The salt obtained after cooling was recrystallised ten times from 60% ethanol (10 ml/g salt). The acid was liberated and recrystallised twice (acetone-benzene) giving plates or flat needles with m.p. 137.5–138°. (Equiv. wt. found 88.6; calc. 88.1. $[\alpha]_D^{25} = +151.8^\circ$ in absolute ethanol).

Desulfurization. Levorotatory acid (200 mg) was refluxed with 5 g freshly prepared W-7 Raney nickel⁵ in dilute sodium carbonate solution for 12 h. The mixture was added to excess hydrochloric acid, and the resulting solution was continuously extracted with ether. The ether solution was evaporated and the residue (150 mg) was recrystallised once from hydrochloric acid, once from benzene; m.p. 131–132°. (Equiv. wt. found 74; calc. 73. $[\alpha]_D^{25} = +8^\circ$ in water; *c* 0.034. Berner⁶ gives m.p. 134–135°; $[\alpha]_D^{25} = +8.0^\circ$ in water.)

The IR-spectrum was in agreement with that of an authentic sample of (+)-dimethylsuccinic acid.⁶ The acid was converted into its anhydride by boiling with acetyl chloride and the anhydride was sublimed at 100° and 15 mm Hg; m.p. 105–107°, $[\alpha]_D^{25} = +117^\circ$ in benzene; *c* 0.005. (Berner⁶ gives $[\alpha]_D^{25} = +116.3^\circ$ in benzene).

In a manner similar to that described above, dextrorotatory acid gave levorota-

tory dimethylsuccinic acid with m.p. 130–131°. ($[\alpha]_D^{25} = -8^\circ$ in water; anhydride: m.p. 105–107°; $[\alpha]_D^{25} = -117^\circ$ in benzene).

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Infrared Spectra of Some Iodine Cyanide Charge Transfer Complexes

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In a previous paper¹ the infrared spectra of some sulphoxide-iodine cyanide complexes were reported as observed in the sodium chloride region. The donor-acceptor interaction between these molecules was demonstrated by the perturbations of the sulphoxide spectra upon complex formation. Thus, common to all the sulphoxides the S=O stretching mode was shifted to lower wave numbers on coordination with iodine cyanide as well as

with iodine and iodine monochloride. Therefore, the complex bond is undoubtedly formed from the oxygen atom in the sulphoxides. It is well known²⁻⁴ that also the acceptor spectrum is perturbed on complex formation and for small molecules like iodine cyanide these changes can more easily be interpreted in terms of increasing complex bond strength.

In the present communication we report the spectral behaviour in the C—I stretching region of iodine cyanide when complexes are formed with a group of five different sulphoxides and with diphenyl selenium oxide. Since tetramethylene sulphoxide was not included in the earlier study¹ this molecule was also investigated in the S=O stretching region and the 1:1 formation constant to iodine cyanide determined.

Experimental. The samples of the sulphoxides^{1,5,6} and the diphenyl selenium oxide⁷ had all been used in the earlier studies. Iodine cyanide from Fluka AG was recrystallized from chloroform. Carbon disulphide and benzene, both *Uvasole* from Merck, were used as solvents. A Perkin-Elmer model 21 spectrometer with sodium chloride optics was employed for the S=O stretching region. The C—I stretching bands were recorded with the aid of a Perkin-Elmer model 337 grating spectrometer. Matched pairs of sealed cells, having the thickness 0.053 and 0.1 cm were used in the two regions, respectively.

The S=O stretching region. When dissolved in carbon disulphide, tetramethylene sulphoxide displays a strong band at 1036 cm⁻¹ and a medium intense band at 1093 cm⁻¹. The former is assigned as the S=O stretching mode, the latter as a ring skeleton frequency. When iodine cyanide was added, the 1036 cm⁻¹ band decreased in intensity and a new peak assigned as the S=O stretching band of the complex appeared at 1010 cm⁻¹. Thus, the shift on complex formation to iodine cyanide was 26 cm⁻¹ compared to 39 cm⁻¹ on complex formation to iodine.⁶ Using the same method as described earlier, the formation constant for the tetramethylene sulphoxide-iodine cyanide complex was calculated to 91 l/mole at 27±1°C, obtained as an average from three mixed donor-acceptor solutions. The formation constant indicates that tetramethylene sulphoxide forms slightly stronger complexes to iodine cyanide¹ than does dimethyl sulphoxide. The same order of basicity was ob-