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SYNTHESIS AND PROPERTIES OF TWO IODOSOLACTONES

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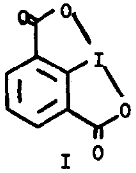
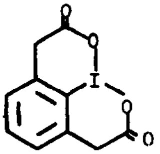
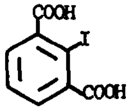
We wish to record the synthesis of two lactones of aromatically bound trivalent iodine, I and II, and to report properties of these substances which may aid in defining more closely the nature of iodine - oxygen bonding in iodosodiesters.



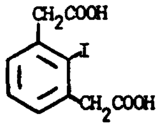
I



II



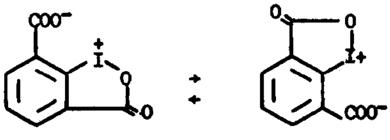
III



IV

Compound I, m.p. 260-264° dec.,[1,2] precipitates slowly in essentially pure form on room temperature oxidation of 2-iodoisophthalic acid[3] (III) in acetic acid - acetic anhydride solution with excess peracetic acid (yield 76%).[4] Compound II, m.p. 198-199° dec.,[1,2] results similarly (58%) from 2-iodo-meta-benzenediacetic acid[3] (IV). Hydriodic acid[5] in dioxan rapidly reconverts each iodosolactone to the corresponding iododicarboxylic acid. The nuclear magnetic resonance (n.m.r.) spectrum of I in deuterodimethyl sulfoxide shows the three aromatic protons as a series of bands at $\delta = 8$, suitable in spacing and intensities for an AB_2 septet with $\delta_A = 7.91$, $\delta_B = 8.20$, $J_{AB} = 7$ c.p.s.[6] The n.m.r. spectrum of II in the same solvent contains a three proton singlet, $\delta = 7.48$ (ArH), and a four proton singlet, $\delta = 3.92$ (CH_2). For comparison the n.m.r. spectra of the iodoacids III and IV were determined under the same conditions. Compound III shows a triplet centered at $\delta = 7.47$, consistent with an AB_2 spectrum, $J = 8$ c.p.s., $|\delta_A - \delta_B| = 0.06$,[6] and the bis-homolog IV has two singlets, $\delta = 7.14$ (ArH), and $\delta = 3.72$ (CH_2). Solutions of both I and II in deuterodimethyl sulfoxide[7] give a single carbonyl band in the infrared at 1686 cm.$^{-1}$

These results are most readily compatible with symmetrical disposition, at least in the time average, of the two side chains in each iodosodilactone and maintenence of the directional properties of both iodine - oxygen bonds in each. Neither the n.m.r. spectra nor the infrared spectra are in accord with those expected for an iodonium cation - carboxylate anion structure such as V, or with a slow equilibrium between two ionic structures such as V and VI.[8] X-ray crystallographic measurements have demonstrated a roughly T-shaped arrangement of groups about iodine in related derivatives of iodosobenzene,[9] and we presume that this geometry obtains for lactones I and II. Models of II constructed on this basis indicate the possibility of two conformers, one with parallel and the other with antiparallel carbonyl groups. The single methylene signal in the n.m.r. spectrum of II, if not accidental, points to conformational flexibility analogous to that of cyclohexane.



V VI

2-Iodoisophthalic acid (III) was prepared from the corresponding amine. Diazotization of 2-aminoisophthalic acid[10] at 0° in concentrated sulfuric acid containing some phosphoric acid,[11] followed by treatment with potassium iodide, gave III in crude yield of 73%. The recrystallized acid melted at 239-240°.[1] Chain lengthening to 2-iodo-meta-benzenediacetic acid (IV) by a double Arndt-Eistert synthesis proceeded in the following fashion. Hot thionyl chloride converted III into the acid chloride, m.p. 73.5-74.5°,[1] (94%, sublimed). This reacted with excess diazomethane in ether to give the bisdiazoketone, which rearranged in methanol containing silver benzoate and triethylamine to furnish ultimately dimethyl 2-iodo-meta-benzenediacetate, m.p. 100-102° (76%).[1] Saponification with aqueous alcoholic base gave dicarboxylic acid IV, m.p. 246.5-248.5° (94%).[1]

Acknowledgement: Professor J. I. Musher of this Institute first suggested synthesis of these iodosobenzenedilactones in his unpublished manuscript, "Higher Valences, Geometrical Isomers, and New Molecules." Discussion of this material with Prof. Musher has contributed appreciably to our investigation.

FOOTNOTES AND REFERENCES

1) Satisfactory elementary analysis was obtained for this new compound.

2) Melting point was determined in an evacuated capillary.

3) The synthesis of III and IV is described below.

4) J. Böeseken and C. Schneider, Konink. Akad. Wetenschap. Amsterdam, Proc. Sci. Sect. **33**, 827 (1930).

5) V. Meyer and W. Wachter, Ber. **25**, 2632 (1892).

6) K. B. Wiberg and B. J. Nist, "The Interpretation of NMR Spectra," W. A. Benjamin, Inc., New York, N. Y., pp. 11-19. Spectra were measured on a Varian Assoc. Model A-60 spectrometer; chemical shifts are expressed in p.p.m. downfield from external tetramethylsilane.

7) Unlike iodosobenzene diacetate and other similar esters, I and II are insoluble in most organic solvents; they are sparingly soluble in tetrahydrofuran and reasonably soluble in dimethyl sulfoxide, from which they may be recovered unchanged. We find the carbonyl frequencies of simple carbonyl compounds normal in deuterodimethyl sulfoxide.

8) From examination of the infrared spectra of several simple iodosobenzene diesters Morgan concluded that these compounds have a "partially zwitterionic structure." R. Bell and K. J. Morgan, J. Chem. Soc. 1209 (1960).

9) (a) $C_6H_5ICl_2$: E. M. Archer and T. G. D. van Schalkwyk, *Acta Cryst.* **6**, 88 (1953).

(b) $(C_6H_5)_2ICl$: T. L. Khotsyanova, *Dokl. Akad. Nauk (SSSR)* **110**, 71 (1956).

(c) *p*-$ClC_6H_4ICl_2$: D. A. Bekoe and R. Hulme, *Nature* **177**, 1230 (1956).

(d) *o*-Iodosobenzoic acid: E. Shefter and W. Wolf, *ibid.* **203**, 512 (1964).

10) E. Noelting and C. Gachot, *Ber.* **39**, 73 (1906), describe the preparation of 2-aminoisophthalic acid by reduction of 2-nitroisophthalic acid with tin in hydrochloric acid. We found catalytic reduction cleaner and more convenient.

11) H. A. J. Schoutissen, *J. Am. Chem. Soc.* **55**, 4531 (1933).