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Esters of 2-Iodoxybenzoic Acid: Novel Periodinanes and Oxidizing Reagents

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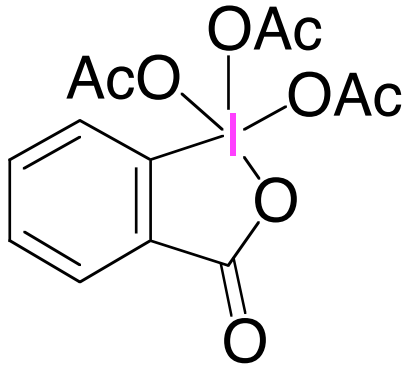
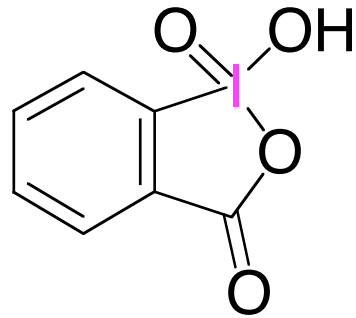
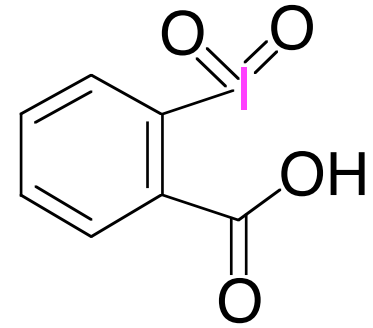
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INTRODUCTION

Organic derivatives of pentavalent iodine have found wide application as oxidizing reagents in the synthesis of biologically important complex organic molecules.¹ The most important representatives of this class of compounds, Dess–Martin periodinane (DMP, **1**) and its precursor benziiodoxol oxide (**2a**), have emerged as the reagents of choice for the oxidation of alcohols to carbonyl compounds and other synthetically useful oxidative transformations.^{1,2} Reagent **2a** is commonly referred to as 2-iodoxybenzoic acid (IBX, **2b**), although the tautomeric form **2a** gives the best representation for the actual structure of this compound. This has been confirmed by X-ray crystallographic analysis for IBX, which also indicates

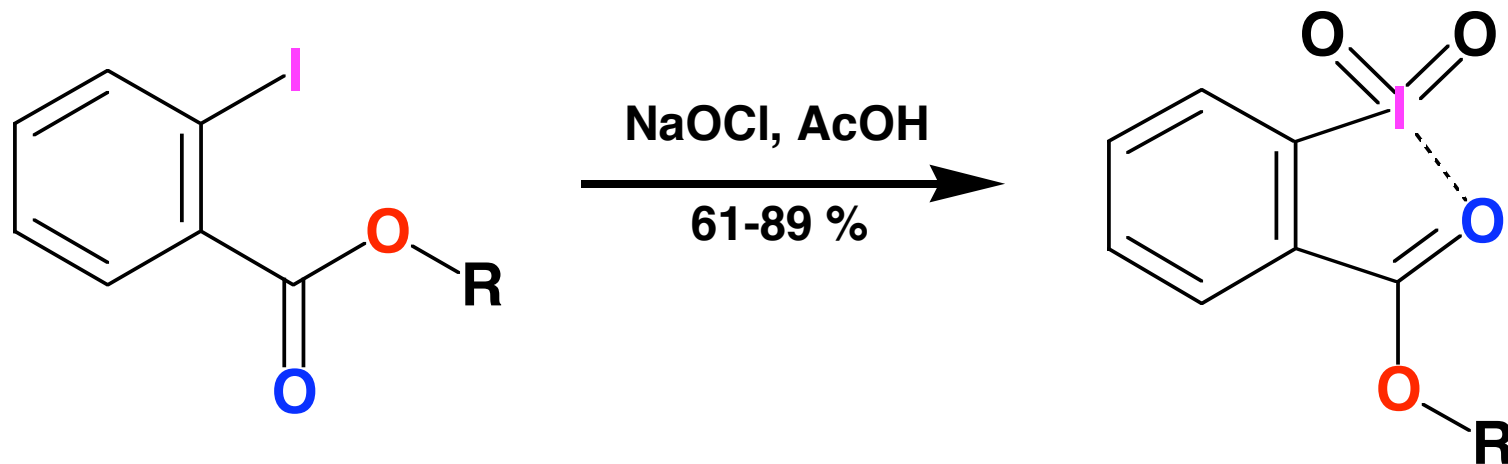
a polymeric structure for IBX due to an extended linkage of intermolecular secondary I•••O bonding interactions.³

The polymeric structure of IBX renders it essentially insoluble in all non-reactive media. The low solubility of IBX and its potentially explosive nature restrict practical application of this reagent. In the present communication, we report the preparation and structure of novel derivatives of 2-iodoxybenzoic acid, namely, IBX-esters **4**, which are stable, soluble reagents with oxidizing properties similar to IBX and DMP. These synthetically valuable characteristics of compounds **4** are best explained by their pseudo cyclic structure in which *intramolecular* secondary I•••O bonds partially replace the *intermolecular* I•••O secondary bonds that afforded the polymeric structure of other reported iodylarenes.

**1****2a****2b**

PREPARATION OF IBX-ESTERS

The new iodoxyarenes **4** were prepared by the hypochlorite oxidation⁴ of the readily available esters of 2-iodobenzoic acid **3** (Scheme 1) and isolated in the form of stable, white, microcrystalline solids. This procedure allows for the preparation of products **4** derived from numerous types of alcohols, such as primary, secondary, and tertiary alcohols, adamantanols, optically active menthols and borneol.



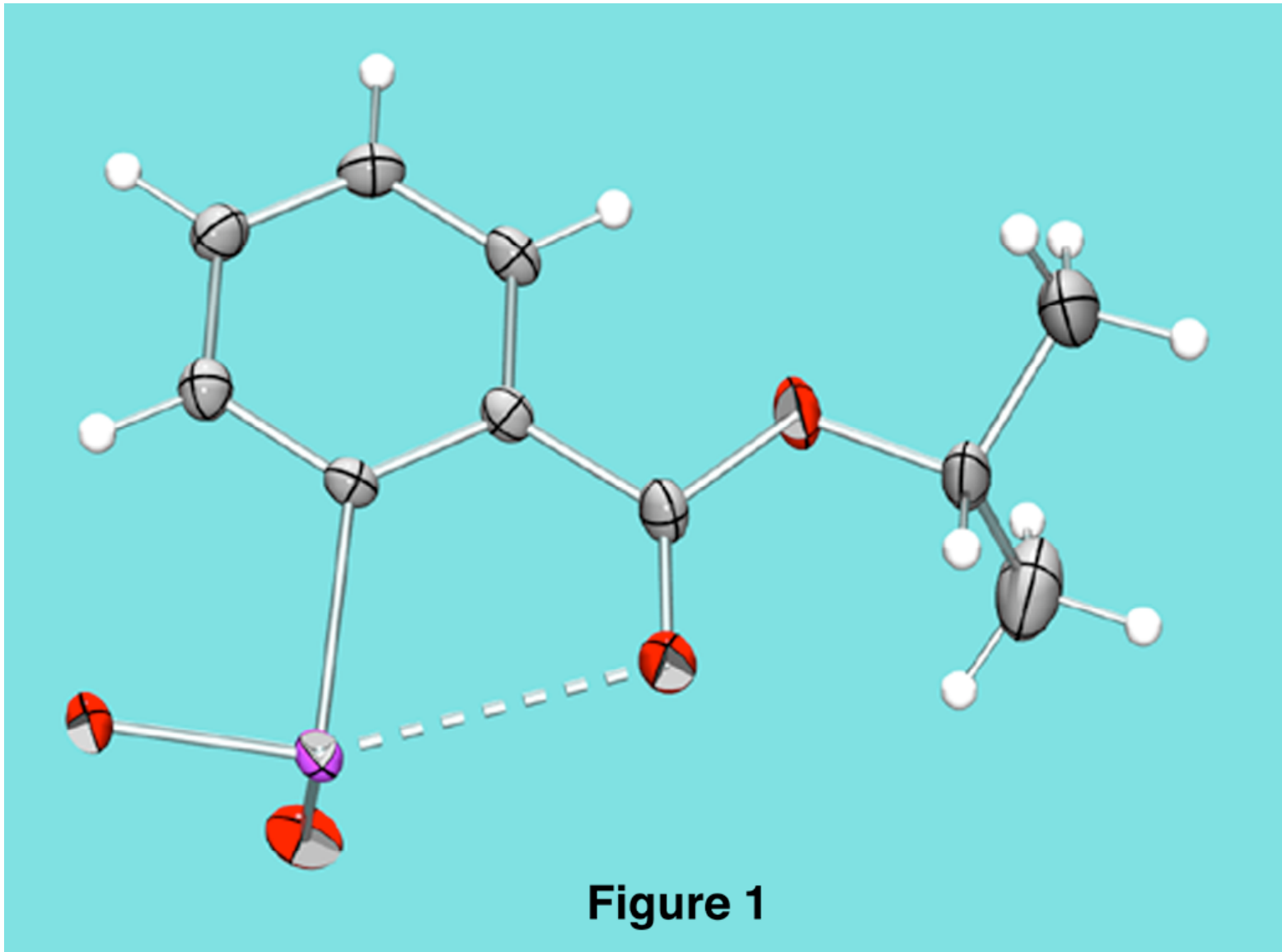
3a-i

4a-i

a, R = Et; **b**, R = *i*-Pr; **c**, R = (-)-menthyl;
d, R = (+)-menthyl; **e**, R = (±)-menthyl;
f, R = [(1*S*)-*endo*]-(-)-bornyl; **g**, R = 2-adamantyl;
h, R = 1-adamantyl; **i**, R = *tert*-Bu

Scheme 1

Products **4** were characterized by elemental analysis, spectroscopic data, ESI mass spectrometry, and single crystal X-ray analysis for **4b** (Figure 1). In particular, IR spectra of all compounds showed the carbonyl stretch at 1670-1630 cm^{-1} , and I=O absorption at 800-730 cm^{-1} . In ^1H NMR, the signals of the aromatic protons and the group R were present. In ^{13}C NMR of **4**, the most characteristic are the signals of the carbonyl carbon at 163-167 ppm and C-IO₂ at 146-149 ppm.



A single crystal of **4b** suitable for X-ray crystallographic analysis was obtained via slow evaporation of an acetonitrile solution. The unit cell consists of four crystallographically independent molecules that are pseudo-centrosymmetrically arranged in a tetrameric structure, as shown in Figure 2. Strong secondary I...O bonding interactions between neighboring molecules of this tetramer enforce this arrangement. Within each molecule, an additional intramolecular close contact of the hypervalent iodine center with the oxygen atom of the ester group (e.g., I1–O13 2.818 Å and I2–O23 2.697) enforces a planar array for the resulting five-membered ring, a geometry that is analogous to IBX and other benziodoxoles.³

The solid state structure suggests that partial replacement of *intermolecular* I•••O bonds with *intramolecular* I•••O bonds by introduction of an ortho–substituent is crucial for stabilization and improved solubility. Furthermore, unlike the discrete tetrameric structure of **4b**, *intermolecular* I•••O interactions in other iodyl benzene derivatives afford structures best described as polymeric, which accounts for their more limited solubility in comparison to **4b**.

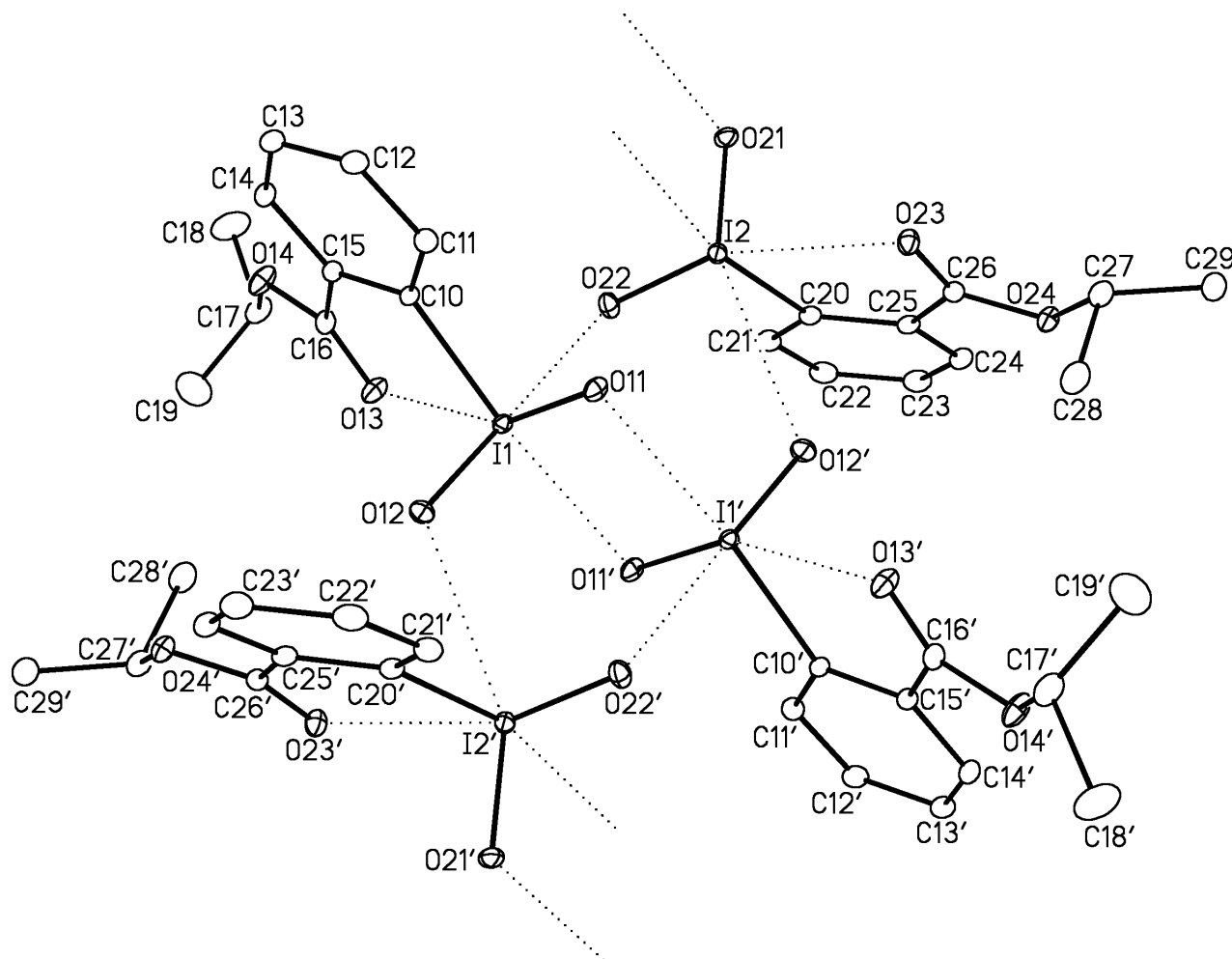
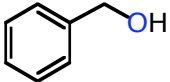
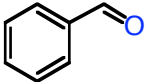
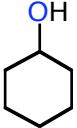
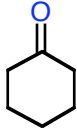
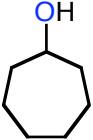
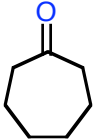
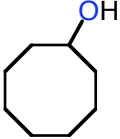
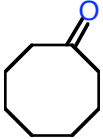
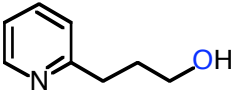
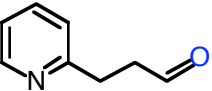


Figure 2. Perspective view of the four crystallographically independent molecules of **4b**. Selected distances [Å] and angles [°]: I–O1 1.8170(15), I–O2 1.8033(17), I–O3 2.8185(17), I–C1 2.138(2); O1–I–C 93.15(8), O2–I–C 94.54(8), O3–I–C 69.14(7).

Preliminary experiments have demonstrated that the new derivatives of 2-iodylbenzoic acid have similar to IBX and DMP oxidizing properties. In particular, a variety of secondary and primary alcohols can be effectively converted to the corresponding carbonyl compounds in excellent yields as determined by GC. For example, reagent **4b** in the presence of trifluoroacetic acid reacts with alcohols in methylene chloride at room temperature in 1-2 hours affording benzaldehyde as the only product detected by GCMS. It should be emphasized that, according to literature data,¹ iodylbenzene, PhIO_2 , as well as other non-cyclic iodylarenes do not react with alcohols.

OXIDATION OF ALCOHOLS WITH REAGENT 4b

Alcohol	Product	Yield
		100%
		95 %
		90 %
		95 %
		50 %

CONCLUSION

In conclusion, we report the preparation and structure of novel IBX-esters **4**, which are stable and soluble compounds with unique and synthetically valuable oxidizing properties. X-Ray data on **4b** reveals a pseudo benziodoxole structure in which the *intramolecular* I•••O secondary bonds partially replace the *intermolecular* I•••O secondary bonds and disrupting the polymeric structure characteristic of PhIO₂ and other previously reported iodylarenes. This structural characteristic substantially increases solubility and stability of these reagents in comparison to other I(V) reagents.

ACKNOWLEDGEMENT

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Selected Experimental Data

Representative procedure: To a rigorously stirred suspension of the ester of 2-iodobenzoic acid **3a** (5 mmol) and sodium hypochlorite solution (“bleach”, 5% NaOCl, 15 mL), glacial acetic acid (5 mL) was added dropwise in a course of 10 minutes. A yellow precipitate was initially formed and later turned white or dissolved. The reaction mixture was stirred overnight and then extracted with 10 mL of dichloromethane three times. The extract was washed with saturated sodium hydrocarbonate and water. After being dried over anhydrous magnesium sulfate, the solvent was evaporated *in vacuo* to afford 0.59 g (61%) of product **4a**, mp 196 °C (from acetonitrile). ¹H NMR (DMSO-d₆): □ 8.27 (m, 1H), 8.07 (m, 2H), 7.77 (m, 1H), 4.45 (q, 2H), 1.38 (t, 3H). ¹³C NMR (DMSO-d₆): □ 162.8, 146.6, 130.6, 127.8, 126.1, 122.1, 119.2, 58.9, 10.0. IR (KBr): 1633 (CO), 804, 732 (IO₂) cm⁻¹. Anal. Calcd for C₉H₉IO₄•H₂O: C, 33.15; H, 3.40; I, 38.92. Found: C, 33.11; H, 3.41; I, 39.08.

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