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Benzyltriethylammonium Dichloroiodate/Sodium Bicarbonate Combination as an Inexpensive, Environmentally Friendly, and Mild Iodinating Reagent for Anilines

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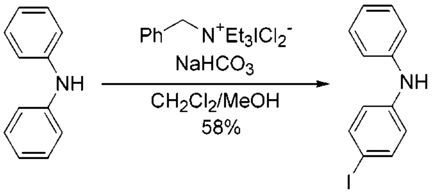
ABSTRACT



Monoiodinated anilines were prepared in good to excellent yields by the action of benzyltriethylammonium dichloroiodate on anilines in the presence of sodium bicarbonate and methanol. The iodinating reagent was prepared in an environmentally friendly fashion without the use of organic solvents.

In the course of our work toward the synthesis of oligo(phenylene ethynylene)diazonium salts, there has been a constant need for iodinated anilines. The mildest and most *para* selective procedures reported in the literature employ benzyltrimethyl (**1**)[1] or benzyltriethylammonium (**2**) dichloroiodates in both free[2] and polymer-supported form.[3] Being fairly straightforward, the synthesis of the dichloroiodate **2** requires corrosive and moisture sensitive iodine monochloride and large amounts of organic solvents (dichloromethane and ethyl ether). Accordingly, we report on the preparation of a benzyltriethylammonium dichloroiodate from inexpensive, easily available reagents in aqueous solution and an improved method for the iodination of anilines that is suitable for molar scale preparations and allows a nearly quantitative recovery of the benzyltriethylammonium cation. Simple recovery of the benzyltriethylammonium cation makes our procedure a more economical alternative than the use of polymer-supported ammonium salts. Tetraethylammonium dichloroiodate (**3**) was also synthesized as a potential reagent for iodinating alkylbenzenes in the presence of Lewis acid catalysts.

The aqueous solution of the dichloroiodate anion was prepared by the action of 5.25% aqueous sodium hypochlorite (common household bleach) on sodium iodide (eq 1) or iodine (eq 2) in the presence of excess hydrochloric acid.

$$\mathrm{NaI} + \mathrm{NaClO} + 2\mathrm{HCl} \rightarrow \mathrm{NaICl_2} + \mathrm{NaCl} + \mathrm{H_2O} \quad (1)$$

$$\mathrm{I_2} + \mathrm{NaClO} + 3\mathrm{HCl} \rightarrow \mathrm{NaICl_2} + \mathrm{HICl_2} + \mathrm{H_2O} \quad (2)$$

Potentially harmful overoxidation of iodine(I) to iodine(III) species was prevented by titration of the dichloroiodate solution with sodium iodide. The resulting orange solution was then added with vigorous stirring to aqueous benzyltriethylammonium chloride. This caused an immediate precipitation of the dichloroiodate **2** as a hydrophobic crystalline material. The preparation of the similar water-insoluble tetraethylammonium salt **3** involved treating tetraethyl-

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[1] Kajigaeshi, S.; Kakinami, T.; Fujisaki, S.; Okamoto, T.; Yamasaki, H. *Bull. Chem. Soc. Jpn.* **1988**, *61*, 600.

[2] Custelceanu, R.; Vlassa, M.; Silberg, I. A. *Monatsh. Chem.* **1997**, *128*, 919.

[3] (a) Mitra, S. S, Sreekumar, K. *Eur. Polym. J.* **1998**, *34*, 561. (b) Mitra, S. S.; Sreekumar, K. *Polym. Int.* **1997**, *42*, 173. (c) Mitra, S. S, Sreekumar, K. *React. Funct. Polym.* **1997**, *32*, 281.

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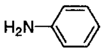
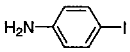
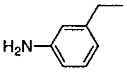
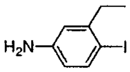
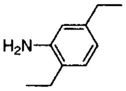
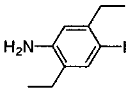
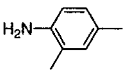
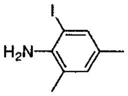
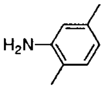
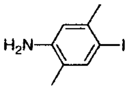
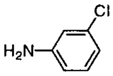
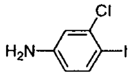
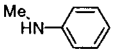
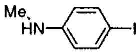
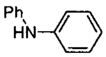
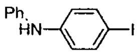
Table 1. Iodination of Anilines with Benzyltriethylammonium Dichloroiodate/Sodium Bicarbonate Reagent

entry	starting aniline	product	yield (%)[a]
1	 **4**	 **12**	99
2	 **5**	 **13**	84
3	 **6**	 **14**	99
4	 **7**	 **15**	78
5	 **8**	 **16**	95
6	 **9**	 **17**	99
7	 **10**	 **18**	98
8	 **11**	 **19**	58[b]

[a] Isolated. [b] 4,4′-Diiododiphenylamine (16%) was also formed.

ammonium iodide with bleach in the presence of hydrochloric acid. In this case, the addition of dichloromethane to the reaction mixture was necessary in order to obtain pure, crystalline salt rather than the gum that would form otherwise.

Treatment of a series of anilines with a combination of the dichloroiodate **2** and sodium bicarbonate in the presence of methanol and dichloromethane resulted in selective monoiodination (Table 1). Even though the monoiodination of alkyl anilines was expected on the basis of the previous results by Kajigaeshi,[1] using a **1**/calcium carbonate combination, the observed monosubstitution selectivity for diphenylamine (Table 1, entry 8) was a welcome surprise. Indeed, the observed bis/mono iodination ratio implies a reaction rate for the introduction of the second iodine atom that is nearly 5 times slower than the rate of the initial iodination.

It was observed that anilines with open *para* positions were iodinated more efficiently (Table 1, entries 1−3 and 5−8) than the ones with only *ortho* positions open for attack (entry 4), the latter giving significant amounts of colored, polar byproducts. In the presence of concerted activation of both *ortho* and *para* positions (entry 2), the *para* selectivity was improved when the reaction was run at 0 °C (the yield at the room temperature was 48%).

The iodination was successfully scaled-up to afford multigram quantities of 4-iodoaniline **12** and 2,5-diethyl-4-iodoaniline **14**. Owing to the predictable and easily controllable behavior of this reaction, it can likely be scaled-up even further. In such a case, recovery of the benzyltrimethylammonium cation may be desirable. An almost quantitative recovery of the cation was achieved in our experiments by acidification of the combined aqueous washings remaining after the extraction of the iodoanilines and the subsequent addition of a fresh batch of the aqueous dichloroiodate.

In this Letter, we have demonstrated that benzyltrimethylammonium dichloroiodate can be expediently prepared without the use of organic solvents and utilized for selective monoiodination of anilines in the presence of sodium bicarbonate and methanol.

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Supporting Information Available: ^{1}H NMR, ^{13}C NMR, IR, and mass spectroscopy for all compounds. This material is available free of charge via the Internet at http://pubs.acs.org.

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