Available online at www.sciencedirect.com

SCIENCE DIRECT®

Tetrahedron Letters 45 (2004) 343–345

Tetrahedron Letters

A facile synthesis of aryl iodides via potassium aryltrifluoroborates

George W. Kabalka[a,b,*] and Arjun R. Mereddy[a,b]

[a]*Department of Chemistry, The University of Tennessee, Knoxville, TN 37966, USA*
[b]*Department of Radiology, The University of Tennessee, Knoxville, TN 37966, USA*

Accepted 24 October 2003

Abstract—Aryl- and heteroaryltrifluoroborates are rapidly converted to aryl and heteroaryl iodides under mild conditions using sodium iodide in the presence of mild oxidizing agents.

Aromatic halides are widely used as synthetic intermediates in organic synthesis.[1] They are also important in medicinal and pharmaceutical research.[2] Organometallic reagents are convenient precursors for the preparation of aryl iodides but their use is somewhat restricted due to the high reactivity and toxic properties of many of the reagents.[3–5] Arylboronic acids and esters can be iodinated under conditions that tolerate a wide variety of functional groups using sodium iodide and oxidants such as chloramine-T.[6] The ready availability of organoboronic acids makes their use as precursors for aryl iodides especially appealing. Unfortunately, arylboronic acids containing electron-withdrawing groups on the aromatic ring are not iodinated effectively.

Potassium aryltrifluoroborates ($ArBF_3K$) have proven to be versatile intermediates in organic synthesis.[7] These salts are readily prepared from boronic acids and are air and water stable.[8] We wish to report that the iodination of potassium aryltrifluoroborates produces aryl iodides regioselectively and in excellent yields (Fig. 1).

The new iodination reactions were carried out using potassium aryltrifluoroborate in 50% aqueous tetrahydrofuran.[9] We investigated a number of oxidizing agents and found chloramine-T to be the most effective (Table 1). The method tolerates a wide variety of functional groups and affords the products in good to excellent yields. Sterically hindered potassium aryltrifluoroborates such as 2-methylphenyl- and 2,6-dimethylphenyltrifluoroborates readily react at room temperature. Aryltrifluoroborates containing electron-withdrawing groups such as 3-nitrophenyl- and 2,6-difluorophenyltrifluoroborates require slightly higher reaction temperatures. Heteroaryltrifluoroborates also undergo the reaction. All products were fully characterized by ^1H and ^{13}C NMR spectroscopies and by comparison with authentic samples.[1,10]

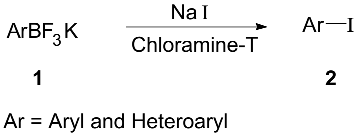


Figure 1.

Table 1. Iodination of potassium 4-methoxyphenyltrifluoroborate using various oxidants[a]

Entry	Oxidant	Time	Yield (%)[b]
1	None	24 h	0
2	Chloroamine-T	30 min	94
3	Peracetic acid	24 h	65
4	MCPBA	24 h	60
5	*t*-BuOOH	24 h	48
6	H_2O_2	24 h	20

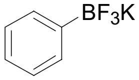
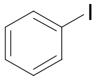
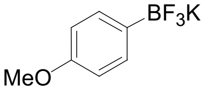
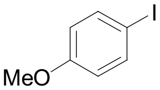
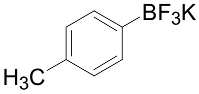
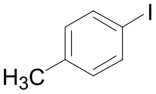
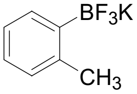
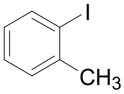
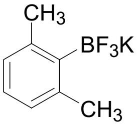
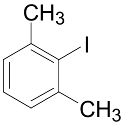
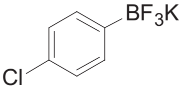
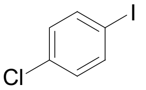
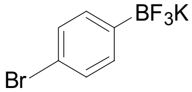
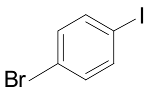
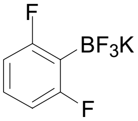
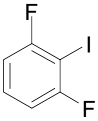
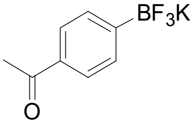
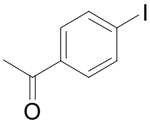
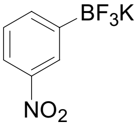
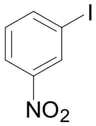
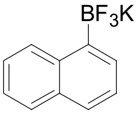
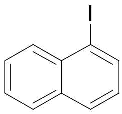
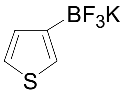
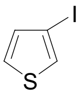
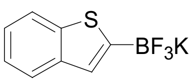
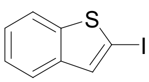
[a] Reaction conditions: trifluoroborate (1.00 mmol), sodium iodide (1.05 mmol), and oxidant (1.00 mmol) in aqueous THF (50%) of room temperature.
[b] Isolated yield.

Keywords: potassium aryltrifluoroborate; aryl iodide; iodination; organoboronic acid.

* Corresponding author. Tel.: +1-8659743260; fax: +1-8659742997; e-mail: kabalka@utk.edu

0040-4039/$ - see front matter © 2003 Elsevier Ltd. All rights reserved.
doi:10.1016/j.tetlet.2003.10.149

Table 2. Synthesis of aryl iodides from potassium arytrifluoroborates[a,b]

Entry	Substrate	Product	Time (min)	Yield (%)[c]
1			10	90
2			10	94
3			10	91
4			10	86
5			15	84
6			15	79
7			15	87
8			120	54[d]
9			90	60
10			120	64[d]
11			10	92
12			10	83
13			10	72

[a] Reaction conditions: trifluoroborate (1.00 mmol), sodium iodide (1.05 mmol), and oxidant (1.00 mmol) in aqueous THF (50%) of room temperature.

[b] All products were characterized ^{1}H, ^{13}C NMR spectroscopy and by comparison to authentic samples.

[c] Isolated yields.

[d] Reaction heated to 50 °C.

The reaction of potassium alkyltrifluoroborates with chloramine-T and sodium iodide was also investigated and found to be less efficient. For example potassium 2-phenyl-1-ethyl- and cyclohexyltrifluoroborates react with chloramine-T and sodium iodide to yield 30% of the expected products after 24 h at reflux.

In conclusion, we report a convenient procedure for preparing aryl iodides from potassium aryltrifluoroborates.

Acknowledgements

We wish to thank the U.S. Department of Energy and the Robert H. Cole Foundation for their support of this research.

References and Notes

1. (a) Diederich, F.; Stang, P. J. *Metal Catalyzed Cross-Coupling Reactions*; Wiley-VCH: Weinheim, Germany, 1998; (b) Miyaura, N.; Yamada, K.; Suginome, H.; Suzuki, A. *J. Am. Chem. Soc.* **1985**, *107*, 972.
2. (a) *Chemistry of Radiopharmaceuticals*; Heindel, N. D., Burns, H. D., Honds, T., Brandy, L. W., Eds.; Masson: New York, 1997; (b) Nicolaou, K. C. *Angew. Chem., Int. Ed. Engl.* **1993**, *32*, 1377.
3. Larock, R. C. *Tetrahedron* **1982**, *38*, 1713.
4. Burnett, D. A.; Caplen, M. A.; Domalski, M. S.; Browne, M. E.; Davis, H. R., Jr.; Clader, J. W. *Bioorg. Med. Chem. Lett.* **2002**, *12*, 311.
5. Pomilio, A. B.; Barolli, M. G. *J. Label. Compd. Radiopharm.* **1997**, *39*, 927.
6. (a) Kabalka, G. W.; Gooch, E. E. *J. Org. Chem.* **1981**, *46*, 2582; (b) Kabalka, G. W.; Sastry, K. A. R.; Hsu, H. C.; Hylarides, D. M. *J. Org. Chem.* **1981**, *46*, 3113; (c) Kabalka, G. W.; Akula, M. R.; Zhang *J. Nucl. Med. Biol.* **2002**, *29*, 841.
7. (a) Vedejs, E.; Chapman, R. W.; Fields, S. C.; Lin, S.; Schrimpf, M. R. *J. Org. Chem.* **1995**, *60*, 3020; (b) Vedejs, E.; Fields, S. C.; Hayashi, R.; Hitchcock, R.; Powell, D. R.; Schrimpf, M. R. *J. Am. Chem. Soc.* **1999**, *121*, 2460; (c) Batey, R. A.; Quach, T. D. *Tetrahedron Lett.* **2001**, *42*, 9099; (d) Molander, G. A.; Ito, T. *Org. Lett.* **2001**, *3*, 393; (e) Molander, G. A.; Biolatto, B. *Org. Lett.* **2002**, *4*, 1867; (f) Pucheault, M.; Darses, S.; Genet, J.-P. *Eur. J. Org. Chem.* **2002**, 3552.
8. Bir, G.; Schachit, W.; Kaufmann, D. *J. Organomet. Chem.* **1990**, *55*, 1868.
9. General procedure: To a solution of potassium aryltrifluoroborate (1.00 mmol) in 50% aqueous tetrahydrofuran (5 mL) contained in a round bottomed flask (which was shielded from light), chloramine-T (1.00 mmol) was added followed by sodium iodide (1.05 mmol). The resulting mixture was stirred at room temperature for the required length of time (Table 2). After the reaction was complete, 10% aqueous sodium thiosulfate (2 mL) was added to decompose excess iodine. The mixture was extracted with ethyl acetate (3 × 25 mL), the combined organic extracts washed with water (20 mL), brine (20 mL), dried over anhydrous sodium sulfate, and concentrated under reduced pressure. The product was purified by column chromatography over silica gel (100–200 mesh) using 98:2 petroleum ether/ethyl acetate. The products were identified by comparison of physical and spectral properties with literature values.
10. Thiebes, C.; Prakash, G. K. S.; Petasis, N. A.; Olah, G. A. *Synlett* **1998**, 141.