Abstract

*m*-Iodosylbenzoic acid performs iodinations of arenes in the presence of iodine at room temperature in acetonitrile. Separation of pure products is conveniently achieved by scavenging any aryl iodide by ion exchange with IRA-900 (hydroxide form). The reduced form of the reagent, *m*-iodobenzoic acid, can be easily recovered from the ion exchange resin or from the basic aqueous solution by simple acidification with HCl.

Background

In recent years, iodoarenes have gained increasing importance because they are widely used as building blocks in organic synthesis. They are particularly important as indispensable substrates for numerous methods of N-N bond formation, [1,2] for the chemistry of heterocyclic [3] and organometallic compounds, [4-8] and for the synthesis of polyvalent iodine organic compounds. [9,10] In addition, polyvalent organoiodine compounds have served as cooxidants in the iodination of arenes. [11-36] Typical polyvalent iodine sources for these iodination reactions are reagents 1–4 (Figure 1). Iodosylbenzene 5 is not suitable for iodinations because of its low activity. [37]

In this report we describe a practical improvement for these iodinations as far as purification of the products and recycling of the iodine reagent is concerned. The broad use of hypervalent iodine reagents is still hampered by tedious purification and recycling protocols. Commonly, purification relies on chromatography. Recently, tagging strategies for reagents and catalysts have widely been investigated that allow easy purification by means of specific phase separation or scavenging. [39-41]

Results and discussion

In this context, we recently described an improved procedure for the preparation of the hardly known *m*-iodosylbenzoic acid 6 and showed that it is a recyclable reagent for the highly efficient RuCl₃-catalyzed oxidation of alcohols to aldehydes and ketones. [42] In the present work we demonstrate the utility of *m*-iodosylbenzoic acid 6 as a recyclable reagent for the iodination of arenes. In fact, this reagent can be regarded as a tagged version of iodosyl benzene 5 which, if used in access, can be conveniently...
removed at the end of the reaction by filtration after addi-
tion of IRA 900 (hydroxide form) (Scheme 1). This scav-
enging concept can also be applied to reduction products
such as m-iodobenzoic acid 9. Importantly, 9 which also
serves as the starting material for the preparation of
6 can easily be regenerated (> 95%) from polymer
10 in pure form by treatment with aqueous HCl.

We found that the reaction of aromatic substrates 7a-o
with I₂ and 6 in CH₃CN (commonly in the presence of
50% aqueous H₂SO₄) led to the corresponding iodinated
arenes in 40 – 99% yield under mild conditions (Scheme
1 and Tables 1 and 2). Addition of aqueous H₂SO₄ accel-
erated the iodination of benzenes. For heteroarenes 7j
and 7o this additive was not required and if an additional
alcohol group was present (see 7n), addition of aqueous
H₂SO₄ resulted in its oxidation. Compared to diaacetoxi-
oodobenzene (DIB) 1a and its polymeric analog 1b, the
use of m-iodosylbenzoic acid 6 for mono- and diiodina-
tion requires the use of smaller amounts of iodine as well
as of the polyvalent iodine reagent. [15] For example, the
preparation of 2,4-diiodoanisole 8k from anisole 7k in
the presence of 1b was achieved using 4.8 equiv. of both
iodine and 1b while our iodination protocol required
only 2.4 equiv. of iodine and 1.2 equiv. of m-iodosylben-
zoic acid 6.

Likewise, for the preparation of aryliodide 8c a 2.4 molar
excess of both iodine and reagent 1a had to be employed
while in our case 1.2 equiv. of iodine and 1.2 equiv. of rea-
gent 6 were required for full conversion.

As is evident from the tables, iodination of arenes that are
acylated like 7d, e, g and 7i commonly led to excellent
yields of selectively iodinated arenes 8d, e, g and 8i.
Increasing the nucleophilicity of the aromatic ring such as
in 3,5-dimethoxybenzyl alcohol 7n led to diiodinated
benzyl alcohol 8n in good yield. Oxidation of the alcohol
group was not observed.

Based on related iodine(III)-mediated iodinations of are-
 nas [12-37] we suggest that the hydrated form of
6 oxidizes iodine to HOI which serves as the reactive
electrophilic intermediate (Scheme 2).

From the results collected it can be concluded that m-
iodosylbenzoic acid 6 shows a similar reactivity as 1-(are-
nesulfonyloxy)benziodoxolones 4a-f [36,37]. However,
reagent 6 is cheaper and exerts better selectivity in the
iodination reactions.

**Conclusion**

In conclusion, we disclose that the rarely employed m-
iodosylbenzoic acid is an ideal tagged iodine(III) reagent
which in our view allows the easiest purification protocol
for aryliodine reagents known so far. This tagging concept
was utilized in the mild iodination of arenes but could
potentially be applied to most other iodine(III)-mediated
reactions.
Table 1: Monoiodination of arenes with m-iodosylbenzoic acid 6 (see Additional File 1 for full experimental data).

| Arene | Iodoarene | Conditions | Yield (%)<sup>a</sup> | mp or bp °C (lit. mp) |
|-------|-----------|------------|------------------------|-----------------------|
| ![Image](7a.png) | ![Image](8a.png) | 5 h, 60°C | 91 | 250–254 (249 – 254; ref. 43) |
| ![Image](7b.png) | ![Image](8b.png) | 24 h, rt | 76<sup>b</sup> | Determined by GC-analysis |
| ![Image](7c.png) | ![Image](8c.png) | 0.5 h, rt | 92 | 62–64 (oil; ref. 10b) |
| ![Image](7d.png) | ![Image](8d.png) | 0.2 h, rt<sup>c</sup> | 90 | 70–72 (71–72; ref. 44) |
| ![Image](7e.png) | ![Image](8e.png) | 0.1 h, rt<sup>c</sup> | 90 | 101–103 (103.6; ref 45) |
| ![Image](7f.png) | ![Image](8f.png) | 0.1 h, rtc<sup>d</sup> | 79 | 8f oil (oil; ref. 46) |
| ![Image](7g.png) | ![Image](8g.png) | 2.0, rt<sup>c</sup> | 85 | 103–105 (105–10; ref. 47) |
| ![Image](7h.png) | ![Image](8h.png) | 16 h, rt | 40 | 95–96 (96; ref 48) |
| ![Image](7i.png) | ![Image](8i.png) | 3.0 h, rt | 60 | 8i : 8i' = 1.0 : 0.8 |
| ![Image](7j.png) | ![Image](8j.png) | 1.0 h, rtc<sup>d</sup> | 97<sup>e</sup> | 134–135 (134–136; ref 49) |

<sup>a</sup> Molar ratio ArH/I<sub>2</sub>/iodine 0.2/0.24/0.12 (in mmol) and 0.05 mL aq. (50%) H<sub>2</sub>SO<sub>4</sub>; isolated yields. <sup>b</sup> Determined by GC-analysis. <sup>c</sup> Instead of 0.05 mL only 0.02 mL aq. (50%) H<sub>2</sub>SO<sub>4</sub> was added. <sup>d</sup> No aq. (50%) H<sub>2</sub>SO<sub>4</sub> was added. <sup>e</sup>NaHCO<sub>3</sub> was used instead of IRA 900 (hydroxide form).
Table 2: Diiodination of Arenes with m-Iodosylbenzoic acid 6 (see Additional File 1 for full experimental data).

| Arene | Diiodoarene | Conditions | Yield (%)<sup>a,b</sup> | mp, °C (lit. mp) |
|-------|-------------|------------|--------------------------|-----------------|
| ![7k](image) | ![8k](image) | 5 h, rt | 91 | 66–67 (67.5–68.5; ref. 10a) |
| ![7l](image) | ![8l](image) | 1.0, rt | 99 | 198–199 (199–200; ref 50) |
| ![7m](image) | ![8m](image) | 0.2 h, rt | 96 | 80–81 (79–80 ref. 10b) |
| ![7n](image) | ![8n](image) | 2 h, rtc | 83 | 146.5–147.5°C (decomp.) |
| ![7o](image) | ![8o](image) | 1 h, rtc | 74<sup>d</sup> | 189–191 (191–192; ref 51) |

<sup>a</sup> Isolated yields. <sup>b</sup> Molar ratio ArH/6/iodine 0.2/0.48/0.24 (in mmol) and 0.05 mL aq. (50%) H<sub>2</sub>SO<sub>4</sub>. <sup>c</sup> No aq. (50%) H<sub>2</sub>SO<sub>4</sub> was added. <sup>d</sup> NaHCO<sub>3</sub> was used instead of IRA 900 (hydroxide form).

### Additional material

**Experimental details.** The data provide general experimental details as well as an improved procedure for the preparation of m-Iodosylbenzoic acid (6), a typical iodination procedure and spectroscopic and analytic data for 8n.

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**Additional File 1**

Experimental details. The data provide general experimental details as well as an improved procedure for the preparation of m-Iodosylbenzoic acid (6), a typical iodination procedure and spectroscopic and analytic data for 8n.
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