## Efficient Conversion of Alkyl Aryl Ketones to Aromatic Carboxylic Acids

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**Abstract:** An efficient method for the conversion of alkyl aryl ketones to aromatic carboxylic acids has been developed based on initial formation of  $\alpha$ -organosulfonyloxy ketones and their subsequent oxidation reactions by tetrabutylammonium periodate in one-pot conditions.

Key words: carboxylic acids, cleavage, ketones, oxidations, periodate.

Conversion of alkyl aryl ketones to aryl carboxylic acids received much attention due to the ready availability of alkyl aryl ketones in industry.<sup>1</sup> Many methods have been reported for the oxidative degradation of alkyl aryl ketones to carboxylic acids. For example various methods utilizing reagents such as sodium bromite,<sup>2</sup> disodium nitrosylpentacyanoferrate(II),<sup>3</sup> sodium nitrite/pyridinium poly(hydrogen fluoride),4 tert-butyl hydroperoxide with Re<sub>2</sub>O<sub>7</sub>,<sup>5</sup> and KOH<sup>6</sup> have been found effective for the oxidative carbon-carbon cleavage reactions of alkyl aryl ketones. However, all of these methods are suffered from the need to use of either strong acidic or basic reaction conditions. There has been only one literature method that conducted under neutral reaction conditions, which utilized  $C_6F_5I(OCOCF_3)_2$  for the carbon-carbon bond cleavage reactions of methyl aryl ketones.<sup>7</sup> However, the modest yields obtained in such reaction conditions limits its practical applications for oxidative cleavage of aromatic ketones. Furthermore, to our knowledge, no description has been reported on the oxidative cleavage of carbon-carbon bond of α-methylene aryl ketones in satisfactory yields under neutral reaction conditions.

As part of our effort to find utilization of reactive  $\alpha$ -organosulfonyloxy ketone intermediates, we now wish to report on the oxidation of alkyl aryl ketones to aromatic carboxylic acids. This method is based on initial  $\alpha$ -organosulfonyloxylation of ketones utilizing [hydroxy(2,4-dinitrobenzenesulfonyloxy)iodo]benzene (HDNIB) and subsequent oxidation of  $\alpha$ -[(2,4-dinitrobenzene)sulfonyloxy ketone intermediates with tetrabutyl ammonium periodate in one-pot experimental manipulations.<sup>8</sup> The required HDNIB was readily prepared in 90% yield by the reaction of iodobenzene diacetate (20.0 mmol) and 2,4- dinitrobenzenesulfonic acid dihydrate (40.0 mmol) in acetonitrile by modification of [hydroxy(tosyloxy)io-

do]benzene (HTIB).<sup>9,10</sup> Treatment of aromatic ketones with HDNIB in CH<sub>3</sub>CN at reflux for 1–2 h produced the  $\alpha$ -[(2,4-dinitrobenzene)sulfonyl]oxy ketone intermediates. Subsequent evaporation of solvent, the residue was treated with Bu<sub>4</sub>NIO<sub>4</sub> at reflux in 1,4-dioxane for additional 2 h to afford the carboxylic acids (Scheme). In the present reaction conditions, both methyl aryl ketones and  $\alpha$ -methylene aryl ketones reacted equally well to provide the corresponding aryl carboxylic acids in high yields.



DNs = 2,4-dinitrobenzenesulfonyl, R = H,  $CH_3$ ,  $CH_2CH_2CH_3$ 

## Scheme

The results are summarized in the Table. When the reaction was conducted by replacing HDNIB by HTIB<sup>11</sup> and [hydroxy(4-nitrobenzenesulfonyloxy)iodo]benzene (HNIB)<sup>9,10</sup> respectively under the same reaction conditions, aromatic carboxylic acids were obtained in poor yields (entries 1 and 8). Therefore the greater reactivity of  $\alpha$ -[(2,4-dinitrobenzene)sulfonyl]oxy ketone intermediates<sup>12</sup> should be associated with the higher leaving ability of  $\alpha$ -[(2,4-dinitrobenzene)sulfonyl]oxy group at nucleophilic substitution reactions. The oxidative cleavage reaction is likely to occur via nucleophilic substitution of -ODNs group in the initially formed  $\alpha$ -[(2,4-dinitrobenzene)sulfonyl]oxy ketone by Bu<sub>4</sub>NIO<sub>4</sub> followed by cleavage reaction of the resultant  $\alpha$ -keto iodate ester intermediates with periodate.<sup>13</sup>

In conclusion, an efficient method for the conversion of alkyl aryl ketones to aromatic carboxylic acids has been developed. On account of its efficiency and neutral reaction conditions, present protocol should be served as a valuable alternative over the existing methods for the carbon-carbon cleavage reactions of alkyl aryl ketones.

Synlett 2001, No. 10, 28 09 2001. Article Identifier: 1437-210X,E;2001,0,10,1563,1564,ftx,en;Y13101st.pdf. © Georg Thieme Verlag Stuttgart · New York ISSN 0936-5214

Table Conversion of Aryl Alkyl Ketones to Carboxylic Acid

Entry	Ketones	Carboxylic acids	Yield (%) <sup>a</sup>
1	Acetophenone	Benzoic acid	75 (30 <sup>b</sup> , 53 <sup>c</sup> )
2	4-Methylacetophenone	4-Methylbenzoic acid	64
3	4-Methoxyacetophenone	4-Methoxybenzoic acid	67
4	4-Chloroacetophenone	4-Chlorobenzoic acid	73
5	4-Bromoacetophenone	4-Bromobenzoic acid	70
6	4-Fluoroacetophenone	4-Fluorobenzoic acid	80
7	4-Nitroacetophenone	4-Nitrobenzoic acid	65
8	Propiophenone	Benzoic acid	68 (25 <sup>b</sup> , 32 <sup>c</sup> )
9	4-Methylpropiophenone	4-Methylbenzoic acid	70
10	4-Methoxypropiophe- none	4-Methoxybenzoic acid	78
11	4-Chloropropiophenone	4-Chlorobenzoic acid	70
12	Valerophenone	Benzoic acid	64
13	2-Acetylthiophene	2-Thiophenecarboxyl- ic acid	60

<sup>a</sup> Isolated yields.

<sup>b</sup> Yields obtained by replacing HDNIB by HTIB at the same reaction conditions.

<sup>c</sup> Obtained by use of HNIB.

## **References and Notes**

- Heaney, H. In Comprehensive Organic Synthesis, Vol. 2; Trost, B. M.; Fleming, I., Eds.; Pergamon Press: New York, 1991, 733.
- (2) Kajigaeshi, S.; Nakagawa, T.; Nagasaki, N.; Fujisaki, S. Synthesis **1985**, 674.
- (3) Kathó, A.; Beck, M. T. Synlett 1992, 165.
- (4) Olah, G. A.; Ramos, M. T.; Wang, Q.; Prakash, G. K. S. Synlett **1991**, 41.
- (5) Gurunath, S.; Sudalai, A. Synlett 1999, 559.
- (6) Žabjek, A.; Petrič, A. Tetrahedron Lett. 1999, 40, 6077.
- (7) Moriarty, R. M.; Prakash, I.; Penmasta, R. J. Chem. Soc., Chem. Commun. 1987, 202.
- (8) Typical experimental procedure: A mixture of acetophenone (1.0 mmol) and HDNIB (1.30 mmol) in 20 mL of acetonitrile was stirred at reflux for 1 h. On completion of reaction, as indicated by TLC, the solvent was evaporated and 1,4-dioxane (20 mL) and tetrabutylammonium periodate (2.0 mmol) was added to the residue. The reaction was continued with stirring at reflux for 2 h. After cooling, the solvent was evaporated and the residue was dissolved in saturated sodium hydrogencarbonate solution. The solution was extracted with ether (2 × 25 mL) and the aqueous layer was acidified with concentrated hydrochloric acid. The aqueous solution was extracted with ether (2 × 30 mL). The combined extracts was dried over MgSO<sub>4</sub> and evaporated to yield pure benzoic acid.
- (9) Koser, G. F.; Wettach, R. H. J. Org. Chem. 1977, 42, 1476.
- (10) HDNIB: mp 152–153 °C; <sup>1</sup>H NMR (300 MHz, DMSO- $d_6$ )  $\delta$ 7.60–7.63 (m, 2 H), 7.67–7.73 (m, 1 H), 8.07 (d, J = 8.7, 1H), 8.19–8.21 (m, 2 H), 8.39 (dd, J = 8.7 Hz, 2.4 Hz, 1 H), 8.55 (d, J = 2.1 Hz, 1 H). Anal. Calcd for C<sub>12</sub>H<sub>9</sub>IN<sub>2</sub>O<sub>8</sub>S: C, 30.78; H, 1.94; I, 27.11. Found: C, 30.69; H, 1.98; I, 26.97.
- (11) Moriarty, R. M.; Vaid, R. K.; Koser, G. F. Synlett 1990, 365.
- (12) The  $\alpha$ -[(2,4-dinitrobenzene)sulfonyl]oxy ketone intermediates are stable and isolable in the range of 75-90% yields. The representative spectral data are as follows:  $\alpha$ -[(2,4dinitrobenzene)sulfonyl]oxy acetophenone: mp 123– 124 °C; <sup>1</sup>H NMR (300 MHz, CDCl<sub>3</sub>)  $\delta$  5.73 (s, 2 H), 7.49– 7.54 (m, 2 H), 7.64–7.66 (m, 1 H), 7.84 (d, *J* = 7.2, 2 H), 8.46 (d, *J* = 8.7, 1 H), 8.59 (dd, *J* = 8.7 Hz, 2.4 Hz, 1 H), 8.68 (d, *J* = 2.1 Hz, 1 H). Anal. Calcd for C<sub>14</sub>H<sub>10</sub>N<sub>2</sub>O<sub>8</sub>S: C, 45.90; H, 2.75. Found: C, 46.34; H, 2.66.
- (13) Johnson, C. R.; Keiser, J. E. Org. Synth. Coll. 1973, Vol. V, 791.