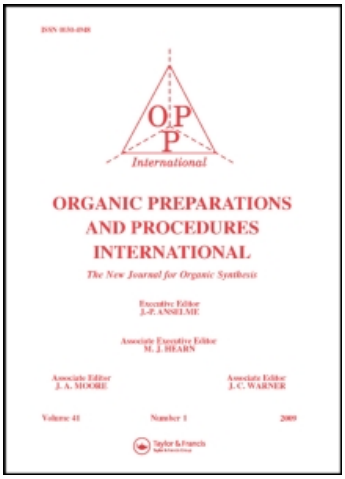


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1. J. H. Macmillan, *Org. Prep. Proced. Int.*, **9**, 87 (1977).

2. J. D. Warren, J. H. MacMillan, and S. S. Washburne, *J. Org. Chem.*, **40**, 743 (1975).

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# DIBROMANTIN AS A REAGENT FOR THE AROMATIC BROMINATION OF POLYALKYLBENZENES

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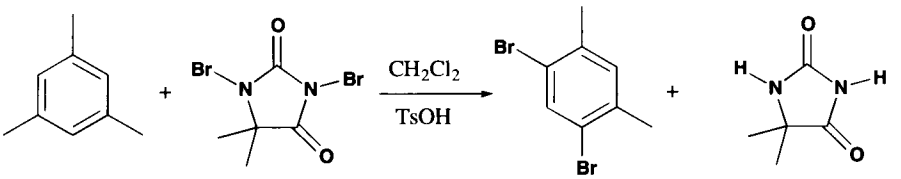
For the past several years, we have explored reagents useful for electrophilic aromatic halogenation.[1] Normally NBS is associated with allylic and benzylic free radical bromination and to a lesser extent as a source of bromonium ions. The same is true for the less expensive dibromantin (1,3-dibromo-5,5-dimethylhydantoin or 1,3-dibromo-5,5-dimethyl-2,4-imidazolidinedione) which, in contrast to NBS, delivers *two* bromines and has been used for allylic bromination in commercial applications.[2] As with NBS, dibromantin (DBH) brominates electron-rich aromatic compounds on




extended reflux in $CCl_4$ with or without free-radical initiators. Orazi and colleagues observed such brominations of aromatic ethers, acetanilides and thiophene by DBH as well as of phenanthrene and related polynuclear aromatics;[3] under such conditions, DBH did not brominate benzene, bromobenzene or naphthalene.[4] The aromatic bromination of activated benzoic acids such as 2,6-dimethoxybenzoic acid with DBH in aqueous base has been accomplished on a pilot plant scale.[5] The present report describes the utility of dibromantin for electrophilic aromatic bromination in combination with moderately acidic catalysts. It complements a recent note that such brominations can be carried out with DBH and very strong acids such as triflic acid and sulfuric acid.[6] In order to determine the optimum conditions for the preparative uses of DBH for aromatic bromination of polyalkylbenzenes, a number of variables were examined at the one millimolar level. Such data (Tables 1-3) served to guide the selections of preparative variables without excessive losses of reagents and solvents.

**TABLE 1.** Effect of Catalysts on the Bromination of Mesitylene by DBH[a]

| Catalyst | Conversion (%) | Selectivity (%) 2-Bromomesitylene | 2,4-Dibromomesitylene |
|---|---|---|---|
| TsOH (17 mol%) | 100 | 5 | 94 |
| $AgNO_3$ (27 mol%) | 97 | 77 | 23 |
| HTIB (10 mol%) | 79 | 96 | 4 |
| PhI $(OAc)_2$ (10 mol%) | 12 | 100 | 0 |
| None ($CH_3CN$) | 39 | 100 | 0 |
| None (water) | 96 | 93 | 5 |
| None ($CH_2Cl_2$) | 15 | 100 | 0 |

a) Mesitylene (1 mmol), DBH (1 mmol) and catalyst (as indicated) in 10 mL of $CH_2Cl_2$ at room temperature overnight. Conversion is the molar percent of unaccounted or unrecovered starting material. Selectivity is the molar percent of a specific product to the unaccounted or unrecovered starting material.



A previous study with NBS revealed that TsOH was a more effective catalyst than the Lewis acid HTIB ([hydroxy (tosyloxy)iodo]benzene).[1b] This difference carried over to DBH as well (Table 2). The NBS/TsOH (cat.) system was ineffective with non-activated rings such as benzene or iodobenzene.[1b] Stoichiometric amounts of $AlCl_3$, $FeCl_3$ and other strong Lewis acids with NBS have been reported as effective combinations for aromatic bromination.[7] The absence of reaction with benzaldehyde suggests that electron-withdrawing groups render the benzene ring inert to DBH. At the other extreme, durene (1,2,4,5-tetramethylbenzene) with an equimolar amount of DBH and TsOH (14 mole%) in $CH_2Cl_2$ was converted completely to dibromodurene (67%) and monobromodurene (33%). Although the additional methyl groups would seem to make durene more reactive than mesitylene, competition experiments with NBS and mesitylene and durene have indicated the reactivity of durene.[1b]

**TABLE 2.** Effect of *p*-Toluenesulfonic Acid on the Bromination of Mesitylene[a]

| TsOH (mole%) | Conversion (%) | Selectivity (%) 2-Bromomesitylene | 2,4-Dibromomesitylene |
|---|---|---|---|
| 0 | 15 | 100 | 0 |
| 1.4 | 70 | 86 | 12 |
| 5.2 | 98 | 56 | 40 |
| 17 | 100 | 5 | 94 |
| 21 | 99 | 6 | 92 |

a) Mesitylene (1 mmol), DBH (1 mmol) and catalyst (mole % based on DBH) in $CH_2Cl_2$ (10 mL) at room temperature overnight.

**TABLE 3.** Effect of Solvents on the Bromination of Mesitylene with DBH[a]

| Solvent | Conversion (%) | Selectivity (%) 2-Bromomesitylene | 2,4-Dibromomesitylene |
|---|---|---|---|
| $CH_2Cl_2$ | 100 | 5 | 94 |
| $CHCl_3$ | 100 | 39 | 61 |
| $CCl_4$ | 37 | 97 | 3 |
| $CH_3CN$ | 100 | 68 | 32 |
| EtOAc | 80 | 100 | 0 |
| $CH_3OH$ | 99 | 64 | 36 |
| $H_2O$ | 100 | 76 | 24 |
| Hexanes | 99 | 89 | 11 |

a) Mesitylene (1 mmol), DBH (1 mmol) and TsOH (0.09-0.17 mmol) in 10 mL of solvent at room temperature overnight.

**TABLE 4.** Comparisons of Substrates with DBH and NBS[a]

| Aromatic | Conversion (%) | Selectivity (%) Bromoaromatic | Dibromoaromatic |
|---|---|---|---|
| Mesitylene | 100 [9] | 5 [100] | 94 [0] |
| Toluene | 100 [2] | 100 [100][b)] | 0 [0] |
| Iodobenzene | 76 [0] | 100 [0][c)] | 0 [0] |
| Durene | 100 [0] | 33 [0] | 67 [0] |
| Naphthalene | 95 [0] | 81 [0][d)] | 16 [0][e)] |
| *p*-Xylene | 19 [0] | 100 [0][f)] | 0 [0] |

a) Aromatic (1 mmol), DBH (1 mmol) or NBS (2 mmol) and TsOH (12-15 mole%) in $CH_2Cl_2$ (10 mL) at room temperature overnight. Values for NBS reactions are in brackets. b) mixture of ortho/para : 55/45 c) mixture of ortho/para : 20/80 d) 1-bromonaphthalene e) 1,5-dibromonaphthalene f) 2-bromo-*p*-xylene

Striking differences exist between the reactivity of NBS and that of the less expensive DBH (Table 4). While NBS can be effective in methanol, under comparable conditions and with an added mole to equalize the ratio of bromine atoms, it was totally ineffective for the bromination of iodobenzene, naphthalene, durene and *p*-xylene. The greater effectiveness of DBH versus NBS was noted by Fujisaki and colleagues for the bromination of toluene catalyzed by a range of acids (but not including TsOH) in equimolar amounts in $CH_2Cl_2$.[6] We have observed that equimolar quantities of triflic acid, DBH and mesitylene in that solvent at room temperature overnight led to yields of dibromomesitylene (97%) and tribromomesitylene (3%). As shown in Table 3, the yield for the dibrominated compound with equimolar amounts of DBH and mesitylene and 15 mole% TsOH was 94%. The use of catalytic amounts of triflic acid instead of TsOH afforded dibromomesitylene (74%) and bromomesitylene (26%). The principal utility of triflic acid in stoichiometric amounts resides in the bromination of

aromatic systems with electron-withdrawing groups. Olah has reported a similar finding in aromatic iodination with *N*-iodosuccinimide.[8] Triflic acid was also used to enhance the reactivity of *N*-chlorosuccinimide for the chlorination of mesitylene.[1b]

From the standpoint of safety, TsOH is preferred to the corrosive triflic acid for preparative scale aromatic brominations where either is effective on a small scale. To this end, experiments were carried out with TsOH for the preparation of 2,4-dibromomesitylene, 2,4,6-tribromomesitylene and 3,6-dibromodurene in 88%, 83% and 73% yields respectively.

## EXPERIMENTAL SECTION

Melting points are uncorrected and were taken on a Hoover-Thomas melting point apparatus. IR spectra were obtained with a Polaris FT-IR Mattson Instruments spectrophotometer. $^1$H NMR spectra were recorded on a Varian Gemini 200 operating in the Fourier Transform mode at 200 MHz. GC and MS analyses were carried out on a Hewlett Packard GC/MS HP5890 with a HP-5 column (95% methyl silicone, 0.25 mm x 30 m). All reactions were protected from light.



**General Analytical Procedure**.- To a solution of the aromatic compound (1 mmol) in 10 mL of $CH_2Cl_2$ was added DBH (1 mmol) and *p*-toluenesulfonic acid (0.15 mmol) in single portions. The solution was stirred overnight at room temperature. The solution was then diluted with 30 mL of ether, washed once with 15 mL of saturated sodium thiosulfate solution, 10 mL of water and 10 mL of saturated sodium chloride solution. After drying over magnesium sulfate, the ether solution was analyzed by GC/MS. The solvent was removed under reduced pressure to afford the brominated product which was weighed and examined by $^1$H NMR to check the GC quantification.

**Preparation of 2,4-Dibromomesitylene**.- A solution of mesitylene (5.00 g, 41.7 mmol) in $CH_2Cl_2$ (150 mL) to which was added DBH (11.9 g, 41.7 mmol) and TsOH (1.18 g, 6.2 mmol) was stirred overnight at room temperature. The mixture was diluted with ether (150 mL) and the ethereal layer was washed with water (50 mL), a saturated solution of $Na_2S_2O_3$ (2x50 mL), a saturated solution of $NaHCO_3$ (2x30 mL), and a saturated solution of NaCl (2x25 mL). The ethereal layer was dried over $MgSO_4$ and evaporated to give 11.0 g (95% crude yield) of a white solid. Crystallization from ethanol afforded 10.2 g (88%) of a white solid, mp. 62-64°, lit. [9] 64°; $^1$H NMR ($CDCl_3$): δ 2.35 (s, 6 H), 2.64 (s, 3 H), 7.00 (s, 1 H); $^{13}$C NMR ($CDCl_3$): δ 24.5, 25.7, 125.3, 130.3, 137.4, 137.8; IR (Nujol) 640 (s), 845 (s), 965 (s), 1030 (s), 1050 (s), 1215 (m) cm$^{-1}$; MS: *m/z* (rel. int.) 280 (51), 278 (100), 276 (59), 199 (73), 197 (74), 117 (41), 115 (46), 91 (18).

**Preparation of 2,4,6-Tribromomesitylene**.- A solution of mesitylene (2.00 g, 16.7 mmol) in $CH_3CN$ (200 mL) to which was added DBH (14.3 g, 50.0 mmol) and TsOH (0.95 g, 5.0 mmol) was heated at reflux overnight. After cooling, a white solid crystallized. It was collected and washed with ether to afford 4.92 g (83%) of a white solid, mp. 224-225°, lit. [10] 224 -225°; $^1$H NMR ($CDCl_3$): δ 2.66 (s, 9 H); $^{13}$C NMR ($CDCl_3$): δ 26.9, 125.4, 137.4; IR (Nujol) 645 (s), 955 (s) cm$^{-1}$; MS: *m/z* (rel. int.) 360 (20), 358 (59), 356 (61), 354 (21), 279 (27), 277 (57), 275 (28), 198 (15), 196 (16), 117 (44), 116 (61), 115 (100).

**Preparation of 3,6-Dibromodurene.** A solution of durene (2.50 g, 18.7 mmol) in $CH_2Cl_2$ (50 mL) to which was added DBH (11.0 g, 38.4 mmol) and TsOH (0.73 g, 3.83 mmol) was stirred overnight at room temperature. The mixture was diluted with ether (250 mL), and the ethereal solution was washed with water (100 mL), a saturated solution of $Na_2S_2O_3$ (2x50 mL), a saturated solution of $NaHCO_3$ (2x50mL), and a saturated solution of NaCl (2x50 mL). The ethereal layer was dried over $MgSO_4$ and evaporated to give 5.47 g (100% crude yield) of a white solid. Crystallization from anhydrous ethanol afforded 3.99 g (73%) of a white solid, mp. 200-201°, lit. [11] 201°; $^1$H NMR ($CDCl_3$): δ 2.49 (s, 12 H); $^{13}$C NMR ($CDCl_3$): δ 22.9, 128.6, 135.5; IR (Nujol) 695 (s), 835 (w), 990 (s), 1175 (s) $cm^{-1}$; MS: *m/z* (rel. int.) 294 (51), 292 (100), 290 (51), 213 (78), 211 (80), 132 (23), 131 (20), 129 (14), 128 (15), 117 (44), 116 (31), 115 (60), 91 (38).

## REFERENCES


1. a) P. Bovonsombat, G. J. Angara and E. Mc Nelis, *Synlett,* 131 (**1992**); b) P. Bovonsombat and E. Mc Nelis, *Synthesis*, 237 (**1993**); c) P. Bovonsombat, E. Djuardi and E. Mc Nelis, *Tetrahedron Lett.*, **35**, 2841 (1994).

2. V. Oakes, H. N. Rydon and K. Undheim, *J. Chem. Soc.*, 4678 (**1962**).

3. a) O. O. Orazi and J. F. Salellas, *An. Asoc. Quim. Argent.*, **38**, 188 (1950); Chem. Abstr., **45**, 2873i (1951); b) J. F. Salellas and O. O. Orazi, *ibid.*, **39**, 175 (1951); Chem. Abstr., **47**, 2708h (1953); c) M. E. Fondovila, O. O. Orazi and J. F. Salellas, *ibid.*, **39**, 184 (1951); Chem. Abstr., **47**, 2709c (1953).

4. J. F. Salellas, O. O. Orazi and R. Ertola, *ibid.*, **38**, 181 (1950); Chem. Abstr., **45**, 2873h (1951).

5. J. Auerbach, S. A. Weissman, T. I. Blacklock, M. R. Angeles and K. Hoogstein, *Tetrahedron Lett.*, **34**, 931 (1993).

6. H. Eguchi, H. Kawaguchi, S. Yoshinaga, A. Nishida, T. Nishiguchi and S. Fujisaki, *Bull. Chem. Soc. Jpn.*, **67**, 1918 (1994).

7. H. Schmid, *Helv. Chim. Acta.*, **29**, 1144 (1946).

8. G. A. Olah, Q. Wang, G. Sandford and G. K. Surya Prakash, *J. Org. Chem.*, **58**, 3194 (1993).

9. R. E. Lutz and G. L. Kibler, *J. Am. Chem. Soc.*, **62**, 1520 (1940).

10. G. F. Hennion and J. G. Anderson, *ibid.*, **68**, 424 (1946).

11. L. I. Smith and C. L. Moyle, *ibid.*, **55**, 1976 (1933).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