



iJRASET

International Journal For Research in
Applied Science and Engineering Technology



INTERNATIONAL JOURNAL FOR RESEARCH

IN APPLIED SCIENCE & ENGINEERING TECHNOLOGY

Volume: 5 Issue: XI Month of publication: November 2017

DOI:

www.ijraset.com

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A Mild and Efficient System for α -Monohalogenation of Carbonyl Compounds Using NBS & SiCl₄

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Abstract: A simple and efficient method for α -halogenation of hydroxylated aromatic ketone using NXS & SiCl₄ in acetonitrile at room temperature is investigated. Using inexpensive and readily available reagents and mild reaction conditions are the major benefits of present method.

Keywords: Tetrachlorosilane, N-halosuccinimide, α -monohalogenation, Hydroxylated aromatic ketone.

I. INTRODUCTION

The Halo carbonyl compounds have wide utility in organic synthesis¹⁻³. These are the building blocks for the synthesis of various heterocycles,⁴ natural products⁵, and many functionalized compounds⁶. A number of α Halocarbonyl compounds possess biological activity⁷. It is well known that the molecular halogen (Br₂/Cl₂/I₂) in presence of some protic acids or Lewis acids is the common reagents for the synthesis of α haloketones from ketones. This method has several drawbacks like toxic and corrosive nature of reagents, difficulty in handling, over halogenations and incompatibility with acid sensitive or easily oxidisable groups⁸. Alternating reagents were reported in the literature for example, Cupric Bromide⁹, NH₄Br-oxane¹⁰. In addition to this a superior halogenating agent such as N-halosuccinimide¹¹ was utilized for α halogenation of carbonyl compounds using a radical initiator such as AIBN¹², in ionic liquid¹³, photochemical energy¹⁴, sonochemical energy¹⁵ some other catalyst like sulfonic acid functionalized silica¹⁸, montmorillonite K10¹⁹. It is well recognized that solids play a significant role in the development of cleaner technologies through their abilities to act as catalyst support reagents, entrain byproducts, and influence product selectivity and several books on application of solids in organic synthesis have appeared. The development of novel synthetic strategies for halogenation which have advantages with respect to using less expensive and readily available reagents, mild reaction conditions, cleaner and simple isolation of the product are of interest. In exploring the utility of in situ reagents based on tetrachlorosilane (TCS)²⁰ in organic synthesis. Here we have reported a general method for the α halogenations of hydroxylated aromatic carbonyl compounds. The process involves sequential reaction of the carbonyl compounds with a combination of inexpensive and readily available tetrachlorosilane and N-halosuccinimide (NXS) under mild conditions in acetonitrile.

II. EXPERIMENTAL

All the chemicals were obtained from E-Merck, India (AR grade) and were used without further purification. Melting points were taken in an open capillary tube. IR spectra were recorded on a Shimadzu Dr-8031 instrument. ¹H NMR spectra of the synthesized compounds were recorded on a Bruker-Avance (300MHz) and Varian-Gemini (200MHz) spectrophotometer using CDCl₃ solvent and TMS as an the internal standard.

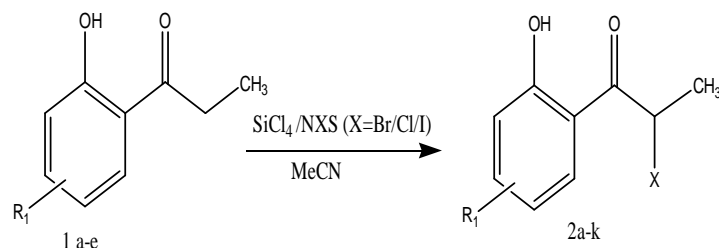
A. General Procedure

To a mixture of 2-hydroxy aryl ketone (100 mmole) and NXS (200mmole) in acetonitrile at room temperature was added SiCl₄ (200 mmole) and the reaction mixture left to stir until the TLC shows disappearance of starting material. Then the reaction mixture was poured in water and extracted with CH₂Cl₂. The extracts were combined, dried over MgSO₄ and the solvent was evaporated. The residue was purified by recrystallization using pet. Ether and diethyl ether (3:1).

III. RESULT AND DISCUSSION

Melting points were determined in an open capillary tube and are uncorrected. IR spectra were recorded in KBr on a FT-IR Perkin-Elmer spectrometer. ¹H NMR spectra were recorded in CDCl₃ as solvent and TMS as internal standard. The purity of compounds was checked by TLC on silica gel.

Scheme



	a	B	C	D	E	f	G	h	I	j	k
R ₁	4-CH ₃	3-CH ₃	5-CH ₃	5-Cl	4-Cl	4-CH ₃	3-CH ₃	5-CH ₃	5-Cl	4-Cl	3-CH ₃
X	Br	Br	Br	Br	Br	Cl	Cl	Cl	I	I	I

2-Bromo-1-(2-Hydroxy-4-methyl-phenyl)-propan-1-one (2a):Yield 68 %, m.p.144⁰C; IR (KBr): 1645 (>C=O), 1590 (>C=C<), 1167 (>C-O) cm⁻¹; ¹HNMR (CDCl₃): δ1.21 (d, 3H,-CHX- CH₃), 2.29(s, 3H, 4Ar-CH₃), δ3.05 (q, 1H,-CHX-CH₃), δ8.12 (m,1H, 3Ar-H)ppm; Anal. Calcd. For C₁₀H₁₁BrO₂, C, 49.41; H, 4.56; Br, 32.87;., 13.16 %.

2-Bromo-1-(2-Hydroxy-3--methyl-phenyl)-propan-1-one (2b):Yield 68 %, m.p.144⁰C; IR (KBr): 1647 (>C=O), 1595 (>C=C<), 1167 (>C-O) cm⁻¹; ¹HNMR (CDCl₃): δ1.21 (d, 3H,-CHX- CH₃), 2.37(s, 3H, 4Ar-CH₃), δ3.02 (q, 1H,-CHX-CH₃), δ8.12 (m,1H, 3Ar-H)ppm; Anal. Calcd. For C₁₀H₁₁BrO₂, C, 49.41; H, 4.56; Br, 32.87;., 13.16 %.

2-Bromo-1-(2-Hydroxy-5-methyl-phenyl)-propan-1-one (2c):Yield 68 %, m.p.148⁰C; IR (KBr): 1645 (>C=O), 1591 (>C=C<), 1167 (>C-O) cm⁻¹; ¹HNMR (CDCl₃): δ1.21 (d, 3H,-CHX- CH₃), 2.37(s, 3H, 4Ar-CH₃), δ3.02 (q, 1H,-CHX-CH₃), δ8.17 (m,1H, 3Ar-H)ppm; Anal. Calcd. For C₁₀H₁₁BrO₂, C, 49.41; H, 4.56; Br, 32.87;., 13.16 %.

2-Bromo-1-(2-Hydroxy-5-chloro-phenyl)-propan-1-one (2d):Yield 81 %, m.p.168⁰C; IR (KBr): 1647 (>C=O), 1593 (>C=C<), 1169 (>C-O) cm⁻¹; ¹HNMR (CDCl₃): δ1.20 (d, 3H,-CHX- CH₃), 2.38(s, 3H, Ar-CH₃), δ3.02 (q, 1H,-CHX-CH₃), δ8.15 (m,1H, 3Ar-H)ppm; Anal. Calcd. For C₉H₈BrClO₂, C, 41.02; H, 3.06; Br, 30.62; Cl, 13.45; O, 12.14 %.

2-Bromo-1-(2-Hydroxy-5-chloro-phenyl)-propan-1-one (2e):Yield 62 %, m.p.158⁰C; IR (KBr): 1645 (>C=O), 1590 (>C=C<), 1167 (>C-O) cm⁻¹; ¹HNMR (CDCl₃): δ1.21 (d, 3H,-CHX- CH₃), 2.37(s, 3H, 4Ar-CH₃), δ3.02 (q, 1H,-CHX-CH₃), δ8.12 (m,1H, 3Ar-H)ppm; Anal. Calcd. For C₉H₈BrClO₂, C, 41.02; H, 3.06; Br, 30.62; Cl, 13.45; O, 12.14 %.

2-Chloro-1-(2-Hydroxy-4-methyl-phenyl)-propan-1-one (2f):Yield 69 %, m.p.128⁰C; IR (KBr): 1645 (>C=O), 1590 (>C=C<), 1167 (>C-O) cm⁻¹; ¹HNMR (CDCl₃): δ1.21 (d, 3H,-CHX- CH₃), 2.37(s, 3H, 4Ar-CH₃), δ3.02 (q, 1H,-CHX-CH₃), δ8.12 (m,1H, 3Ar-H)ppm; Anal. Calcd. For C₉H₈BrClO₂, C, 60.46; H, 5.58; Cl, 17.85; O, 16.11 %.

2-Chloro-1-(2-Hydroxy-3-methyl-phenyl)-propan-1-one (2g):Yield 72 %, m.p.138⁰C; IR (KBr): 1649 (>C=O), 1595 (>C=C<), 1169 (>C-O) cm⁻¹; ¹HNMR (CDCl₃): δ1.21 (d, 3H,-CHX- CH₃), 2.38(s, 3H, 4Ar-CH₃), δ3.03 (q, 1H,-CHX-CH₃), δ8.10 (m,1H, 3Ar-H)ppm; Anal. Calcd. For C₉H₈BrClO₂, C, 60.46; H, 5.58; Cl, 17.85; O, 16.11 %.

2-Chloro-1-(2-Hydroxy-5-methyl-phenyl)-propan-1-one (2h):Yield 62 %, m.p.132⁰C; IR (KBr): 1644 (>C=O), 1595 (>C=C<), 1167 (>C-O) cm⁻¹; ¹HNMR (CDCl₃): δ1.21 (d, 3H,-CHX- CH₃), 2.39(s, 3H, 4Ar-CH₃), δ3.05 (q, 1H,-CHX-CH₃), δ8.17 (m,1H, 3Ar-H)ppm; Anal. Calcd. For C₉H₈BrClO₂, C, 60.46; H, 5.58; Cl, 17.85; O, 16.11 %.

2-Iodo-1-(2-Hydroxy-5-chloro-phenyl)-propan-1-one (2i):Yield 80 %, m.p.155⁰C; IR (KBr): 1647 (>C=O), 1594 (>C=C<), 1162 (>C-O) cm⁻¹; ¹HNMR (CDCl₃): δ1.21 (d, 3H,-CHX- CH₃), 2.37(s, 3H, 4Ar-CH₃), δ3.02 (q, 1H,-CHX-CH₃), δ8.12 (m,1H, 3Ar-H)ppm; Anal. Calcd. For C₉H₈BrClO₂, C, 60.46; H, 5.58; Cl, 17.85; O, 16.11 %.

2-Iodo-1-(2-Hydroxy-4-methyl-phenyl)-propan-1-one (2j):Yield 62 %, m.p.148⁰C; IR (KBr): 1645 (>C=O), 1590 (>C=C<), 1167 (>C-O) cm⁻¹; ¹HNMR (CDCl₃): δ1.21 (d, 3H,-CHX- CH₃), 2.37(s, 3H, 4Ar-CH₃), δ3.02 (q, 1H,-CHX-CH₃), δ8.12 (m,1H, 3Ar-H)ppm; Anal. Calcd. For C₉H₈BrClO₂, C, 34.81; H, 2.60; Cl, 11.42; I, 40.87; O, 10.31 %.

2-Iodo-1-(2-Hydroxy-4-methyl-phenyl)-propan-1-one (2k):Yield 62 %, m.p.148⁰C; IR (KBr): 1645 (>C=O), 1590 (>C=C<), 1167 (>C-O) cm⁻¹; ¹HNMR (CDCl₃): δ1.21 (d, 3H,-CHX- CH₃), 2.37(s, 3H, 4Ar-CH₃), δ3.02 (q, 1H,-CHX-CH₃), δ8.12 (m,1H, 3Ar-H)ppm; Anal. Calcd. For C₉H₈BrClO₂, C, 34.81; H, 2.60; Cl, 11.42; I, 40.87; O, 10.31 %.

IV. CONCLUSIONS

The we have developed a practical and efficient method for the α monohalogenation of carbonyl compounds using cheap and readily available tetrachlorosilane and N-halosuccinimide. This method can be applied to a wide range of carbonyl compounds. The

halogen atom can be introduced to the substrate with high regioselectivity. The mild reaction conditions, easy work up procedure and simple operation are advantages of this procedure.

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