SHORT PAPER

J. Chem. Research (S),
2001, 108–109

Synthesis of quinolines: reductive coupling reactions of 2-nitro-1,3-diphenyl-2-propen-1-one induced by low-valent titanium[†]

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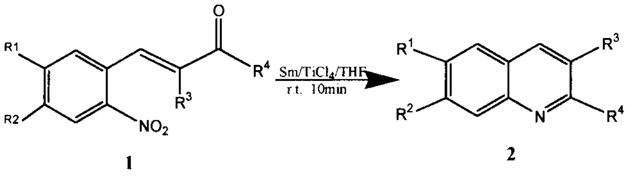
The intramolecular reductive cyclisations of 2-nitro-1,3-diphenyl-2-propen-1-ones (**1**) induced by the Sm/$TiCl_4$ system were studied; 2-arylquinolines (**2**) are obtained in moderate yields under room temperature conditions.

Keywords: quinolines, 2-nitro-1,3-diphenyl-2-propen-1-ones

Quinolines are constituents of many naturally occurring substances[1] and synthetic compounds of biological significance.[2] Various methods are known for the synthesis of quinolines.[1,3] For example, quinolines could be synthesised by heating aniline with glycerine, sulfuric acid, and an oxidising agent.[4] Also, aromatic imines could react with phenylacetylene or styrene in an acetonitrile solution of iron (III) chloride to give quinolines.[5] Furthermore, the synthesis of some quinolines through palladium-catalysed reactions have been reported.[6] Alternatively, Boxi has reported the preparation of quinoline derivatives by reduction of suitably functionalised *o*-nitroarenes with Zn powder in H_2O at 250°C.[7]

Carbon–carbon bond formation is the essence of organic synthesis and the reductive coupling of carbonyl derivatives is one of the most valuable methods for establishing carbon–carbon bonds. Low-valent titanium reagents have an exceedingly high ability in promoting reductive coupling of carbonyl compounds and are attracting increasing interest in organic synthesis. A lot of other functional groups can also be coupled by this reagent.[8] Recently, we have reported a reductive cleavage reaction of Se–Se bonds, Te–Te bonds and reductive coupling of nitriles with nitro compounds using the $TiCl_4$/Sm/THF system.[9] Here, we wish to describe a new synthetic method for reducing *o*-nitrochalcones by the $TiCl_4$/Sm/THF system to give 2-arylquinolines.

When *o*-nitrochalcones (**1**) were treated with low-valent titanium, prepared from titanium tetrachloride and samarium powder in anhydrous THF, the intramolecular reductive coupling products (**2**) are obtained in moderate yields (Scheme 1). The results are summarized in Table 1.



Scheme 1

However, when 1-methyl-3-(2′-nitrophenyl)-2-propen-1-one (entry 2j) was treated by the $TiCl_4$/Sm system, the predicted product 2-methylquinoline could not be obtained.

Although there have been many methods of preparing 2-arylquinolines, most of these methods have certain disadvantages such as harsh reaction condition, laborious manipulation or lower yield. The present method has the advantages of accessible starting materials, simple and mild reaction conditions, convenient manipulation and moderate yields. Further studies to develop other new uses of the $TiCl_4$/Sm system are now in progress.

Table 1 The synthesis of 2-arylquinolines promoted by low-valent titanium

Entry	R^1	R^2	R^3	R^4	Yield (%)*
2a	H	H	H	C_6H_5	67
2b	H	H	H	*p*-$CH_3C_6H_4$	70
2c	H	H	H	*p*-ClC_6H_4	65
2d	H	H	H	*p*-BrC_6H_4	72
2e	H	H	H	*p*-$CH_3OC_6H_4$	62
2f	H	H	CH_3	C_6H_5	54
2g	-OCH_2O-		H	C_6H_5	68
2h	-OCH_2O-		H	*p*-$CH_3C_6H_4$	66
2i	-OCH_2O-		H	*p*-BrC_6H_4	60
2j	H	H	H	CH_3	—

*Isolated yield.

Experimental

General: Tetrahydrofuran was distilled from sodium-benzophenone immediately prior to use. All reactions were conducted under a nitrogen atmosphere. Melting points are uncorrected. Infrared spectra were recorded on a Perkin-Elmer 683 spectrometer in KBr with absorptions in cm^{-1}. ^1H-NMR spectra were recorded on a Bruker AC 80 spectrometer as $CDCl_3$ solutions. Chemical shifts were expressed in ppm downfield from internal standard tetramethylsilane. Mass spectra were recorded on an HP5989B Mass spectrometer. Elemental analyses were carried out on an EA 1110 instrument.

Synthesis of 2-arylquinolines (**2**): $TiCl_4$ (0.22 ml, 2 mmol) was added dropwise using a syringe to a stirred suspension of Sm powder (0.3 g, 2 mmol) in freshly distilled dry THF (15 ml) at room temperature under N_2. After the completion of the addition, the mixture was refluxed for 2h. The suspension of the low-valent titanium reagent formed was cooled to room temperature and a solution of 2-nitrochalcones (**1**) (1 mmol) in anhydrous THF (3 ml) was added. The mixture was stirred for 10 minutes at room temperature under N_2 (the reaction was monitored by TLC). The reaction mixture was quenched then with 0.1N HCl (3 ml) and extracted with diethyl ether (3 × 15 ml). The combined extracts were washed with a saturated solution of $Na_2S_2O_3$ (15 ml) and a saturated solution of NaCl (15 ml) and dried over anhydrous Na_2SO_4. After evaporation of the solvent under reduced pressure, the crude products **2a–i** were purified by preparative TLC on silica gel using ethyl acetate-cyclohexane (1:8) as eluent.

2-phenylquinoline (**2a**): m.p. 79–81°C (lit[6b] 83°C). ν_{max} (cm^{-1}) 1620 (C=N). δ_H (ppm) 7.35–8.20 (m).

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[†] This is a Short Paper, there is therefore no corresponding material in *J Chem. Research (M).*

2-(4′-methylphenyl)quinoline (**2b**): m.p. 78–80°C (lit[6b] 81–82°C). ν_{max} (cm^{-1}) 1620 (C=N). δ_H (ppm) 2.43 (3H, s), 7.27–8.25 (10H, m).

2-(4′-chlorophenyl)quinoline (**2c**): m.p. 98–100°C. ν_{max} (cm^{-1}) 1615 (C=N). δ_H (ppm) 7.20–8.22 (m). *m/z*: 239 (M$^+$, 100). $C_{15}H_{10}ClN$ Calcd. C, 75.16; H, 4.20; N, 5.84; Found: C, 74.95; H, 4.18; N, 5.86.

2-(4′-bromophenyl)quinoline (**2d**): m.p. 120–122°C. ν_{max} (cm^{-1}) 1615 (C=N). δ_H (ppm) 7.37–8.19 (m). *m/z*: 283 (M$^+$, 100). $C_{15}H_{10}BrN$ Calcd. C, 63.40; H, 3.55; N, 4.93; Found: C, 63.18; H, 3.59; N, 4.94.

2-(4′-methoxyphenyl)quinoline (**2e**): m.p. 122–124°C(lit[6b] 122–123°C). ν_{max} (cm^{-1}) 1620 (C=N). δ_H (ppm) 3.75 (3H, s), 7.09–8.17 (10H, m).

2-phenyl-3-methyl-quinoline (**2f**): m.p. 84–86°C. ν_{max} (cm^{-1}) 1620 (C=N). δ_H (ppm) 2.44 (3H, s), 7.40–8.28 (10H, m). *m/z*: 219 (M$^+$, 100). $C_{16}H_{13}N$ Calcd. C, 87.64; H, 5.98; N, 6.39; Found: C, 87.50; H, 5.98; N, 6.41.

2-phenyl-6,7-methylenedioxy-quinoline (**2g**): m.p. 146–148°C. ν_{max} (cm^{-1}) 1620 (C=N). δ_H (ppm) 6.10 (2H, s), 7.04–8.06 (9H, m). *m/z*: 249 (M$^+$, 100). $C_{16}H_{11}NO_2$ Calcd. C, 77.10; H, 4.45; N, 5.62; Found: C, 76.85; H, 4.44; N, 5.66.

2-(4′-methylphenyl)-6,7-methylenedioxy-quinoline (**2h**): m.p. 112–114°C. ν_{max} (cm^{-1}) 1620 (C=N). δ_H (ppm) 2.03 (3H, s), 6.09 (2H, s), 7.05–8.16 (8H, m). *m/z*: 263 (M$^+$, 100). $C_{17}H_{13}NO_2$ Calcd. C, 77.55; H, 4.98; N, 5.32; Found: C, 77.29; H, 5.01; N, 5.33.

2-(4′-bromophenyl)-6,7-methylenedioxy-quinoline (**2i**): m.p. 202–204°C. ν_{max} (cm^{-1}) 1615 (C=N). δ_H (ppm) 6.12 (2H, s), 7.10–8.26 (8H, m). *m/z*: 327 (M$^+$, 100). $C_{16}H_{10}BrNO_2$ Calcd. C, 58.56; H, 3.07; N, 4.27; Found: C, 58.32; H, 3.09; N, 4.30.

We are grateful to the National Natural Science Foundation of China (Project No.29872010) and the NSF of Zhejiang Province, China for financial support.

Received 28 November 2000; accepted 22 January 2001
Paper 00/612

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