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A Facile Route to Functionalized 1-Arylsulfonyl-1,2-dihydroquinolines

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Summary. A one-pot synthesis of dialkyl 1-arylsulfonyl-1,2-dihydroquinoline-2,3-dicarboxylates by reaction of arylsulfonamide derivatives of 2-aminobenzaldehyde, dialkyl acetylenedicarboxylates, and triphenylphosphine in excellent yields is reported.

Keywords. 1,2-Dihydroquinoline; Arylsulfonamides; Intramolecular *Wittig* reaction; Acetylenic esters; Triphenylphosphine.

Ein einfacher Weg zu funktionalisierten 1-Arylsulfonyl-1,2-dihydrochinolinen

Zusammenfassung. Es wird über eine Eintopfsynthese zur Herstellung von Dialkyl-1-arylsulfonyl-1,2-dihydrochinolin-2,3-dicarboxylaten durch Umsetzung von Arylsulfonamid berichtet. Die Reaktion liefert ausgezeichnete Ausbeuten.

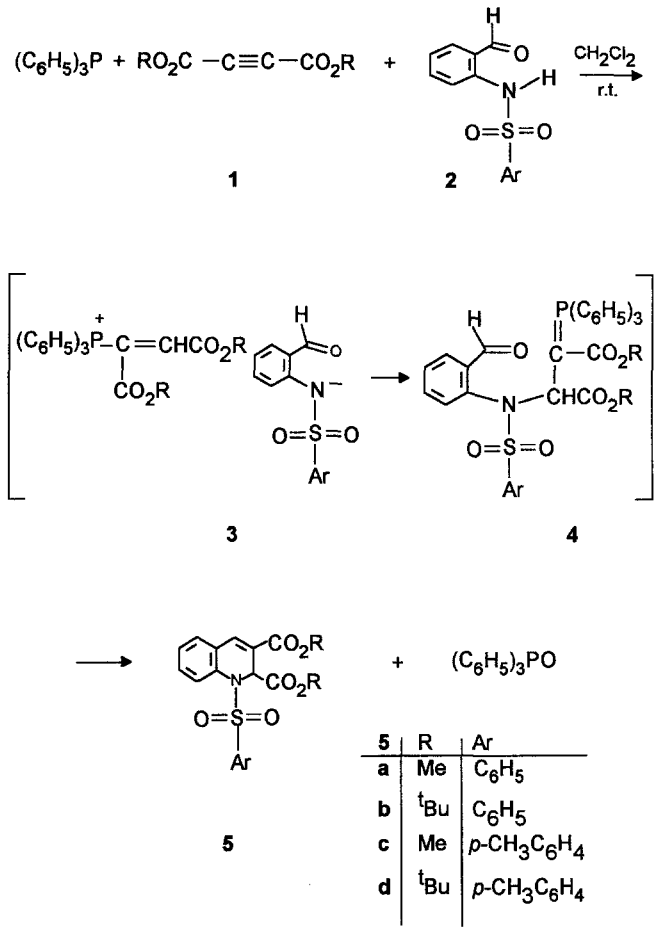
Introduction

The synthesis of 1,2-dihydroquinolines has usually been accomplished by reduction of quinoline compounds [1, 2]. The most common reagents for carrying out this reduction are lithium aluminum hydride [3,4], dialkylaluminum hydrides [5], and sodium in liquid ammonia [6]. 1,2-Dihydroquinolines have also been prepared by elimination from substituted tetrahydroquinolines [7].

Dihydroquinoline syntheses by ring closure strategies are not common. Although several of the ring closure reactions leading to quinolines (*e.g. Doebner-Miller* synthesis, *Skraup* synthesis, *Combes* synthesis) pass through dihydroquinoline intermediates, the development of a dihydroquinoline synthesis from these reactions has not been accomplished. Recently, we have established a method for heterocyclic synthesis using a novel approach employing vinylphosphonium salts [8,9]. We here describe a facile one-pot synthesis of dialkyl 1-arylsulfonyl-1,2-dihydroquinoline-2,3-dicarboxylates (**5**) in excellent yields.

Results and Discussion

Reactions are known in which an unsaturated heterocyclic compound is produced from a phosphorane connected with a carbonyl group by a chain containing a



5	R	Ar
a	Me	C_6H_5
b	^{t}Bu	C_6H_5
c	Me	p-$CH_3C_6H_4$
d	^{t}Bu	p-$CH_3C_6H_4$

Scheme 1

heteroatom (10–12). Thus, dihydroquinolines **5** may be regarded as the product of an intramolecular *Wittig* reaction. Such addition-cyclization products apparently result from an initial addition of triphenylphosphine to the acetylenic ester and concomitant protonation of the 1:1 adduct, followed by attack of the sulfonamide anion derivative on the vinylphosphonium cation to form phosphorane **4** which is converted into dihydroquinolines.

The nature of compounds **5a–d** as addition-cyclization products was deduced from their elemental analyses and their mass spectra which displayed molecular ion peaks at $m/z = 387$, 471, 401, and 485. Initial fragmentations involve loss of the quinoline side chains (–O*R*, *R*OH, $-CO_2$, $ArSO_2$). The base peak in each spectrum is assigned to the alkyl 1-arylsulfonylquinoline-3-carboxylate ion.

The ^{1}H NMR spectrum of **5a** exhibited five singlets arising from methoxy ($\delta = 3.62$ and 3.82 ppm), N–CH ($\delta = 6.20$ ppm) and olefinic CH ($\delta = 7.25$ ppm) protons, along with a fairly complex multiplet in the aromatic region (see Experimental). The BB decoupled ^{13}C NMR spectrum of **5a** displayed seventeen distinct resonance in agreement with the dihydroquinoline structure. Partial assignments of these resonances are given in the Experimental.

The ^1H and ^{13}C NMR spectra of **5b–d** are similar to those of **5a** except for the ester groups and arylsulfonamide moiety, which give rise to characteristic signals with appropriate chemical shifts (see Experimental).

The structural assignments performed on the basis of the ^1H and ^{13}C NMR spectra of compounds **5a–d** were supported by their IR spectra the carbonyl region of which displayed two distinct absorption bands for each compound (see Experimental). Of special interest is the ester absorption at 1701–1698 cm^{-1}: conjugation with the carbon–carbon double bond appears to be a plausible factor in the marked wave number reduction of these bands. Sulfonamides **5a–d** absorb strongly at 1380–1361 and 1165–1153 cm^{-1}.

The advantage of the synthesis described herein is that it provides a convenient method of closing a ring directly to a 1,2-dihydroquinoline. The one-pot nature of the procedure makes it an alternative to multistep approaches. Further applications of this type of addition-cyclization to the synthesis of interesting heterocycles will be reported in due course.

Experimental

Melting points were measured on an Electrothermal 9100 apparatus and are uncorrected. Elemental analyses were performed using a Heraeus CHN-O-Rapid analyzer. IR spectra were recorded on a Shimadzu IR-460 spectrometer. ^1H and ^{13}C NMR spectra were measured with JEOL EX-90A spectrometer at 90 and 22.6 MHz, respectively. Mass spectra were recorded on a Finnigan-Mat 8430 mass spectrometer operating at an ionization potential of 70 eV. Dimethyl acetylenedicarboxylate, di-*tert*-butyl acetylenedicarboxylate, benzenesulfonyl chloride, *p*-toluenesulfonyl chloride, and 2-aminobenzyl alcohol were obtained from Fluka (Buchs, Switzerland) and were used without further purification. 2-Benzenesulfonamidobenzyl alcohol (**6a**) and 2-*p*-toluenesulfonamidobenzyl alcohol (**6b**) were prepared from 2-aminobenzyl alcohol and corresponding arylsulfonyl chlorides by known methods [13]. Pyridinium chlorochromate oxidation [14] of **6a** and **6b** yielded **2a** and **2b**, respectively. Compounds **6a**, **6b**, **2a**, and **2b** were characterized as given below.

6a: White crystals; m.p.: 126–127°C; ^1H NMR ($CDCl_3$): $\delta = 2.7$ (1H, br s, OH), 4.41 (2H, s, CH_2-Ar), 7.0–7.9 (9H, m, arom.), 8.7 (1H, br s, $NHSO_2$) ppm; ^{13}C NMR ($CDCl_3$): $\delta = 62.14$ (CH_2), 123.63, 125.46, 128.23, 132.75 (4 CH), 126.76 (2 CH), 128.88 (2 CH), 129.78, 133.69, 135.56, 139.79 (4 C) ppm.

6b: Light-yellow crystals; m.p.: 149–150°C; ^1H NMR (CD_3COCD_3): $\delta = 2.25$ (3H, s, CH_3), 4.50 (2H, s, CH_2-Ar), 4.7 (1H, br s, OH), 7.0–7.8 (8H, m, arom.), 8.7 (1H, br s, $NHSO_2$) ppm; ^{13}C NMR (CD_3COCD_3): $\delta = 21.87$ (CH_3), 63.69 (CH_2), 124.20, 126.36, 129.37, 129.66 (4 CH), 128.36 (2 CH), 130.88 (2 CH), 134.79, 137.60, 138.94, 145.01, (4 C) ppm.

2a: Light-brown crystals; m.p.: 118°C; ^1H NMR ($CDCl_3$): $\delta = 7.0$–8.0 (9H, m, arom.), 9.82 (1H, s, CHO), 10.9 (1H, br s, $NHSO_2$)ppm; ^{13}C NMR ($CDCl_3$): $\delta = 117.64$, 123.30, 133.36, 135.84, 136.29 (5 CH), 127.05 (2 CH), 129.21 (2 CH), 121.96, 139.10, 139.51 (3 C), 195.34 (CHO) ppm;

2b: Light-brown crystals; m.p.: 141–142°C; ^1H NMR ($CDCl_3$): $\delta = 2.40$ (3H, s, CH_3), 7.1–7.9 (8H, m, arom.), 9.88 (1H, s, CHO), 10.8 (1H, br s, $NHSO_2$) ppm; ^{13}C NMR ($CDCl_3$): $\delta = 21.50$ (CH_3), 117.72, 123.06, 135.80, 136.17 (4 CH), 127.21 (2 CH), 129.78 (2 CH), 121.92, 136.37, 139.88, 144.27 (4 C), 195.09 (CHO) ppm;

Dimethyl N-benzenesulfonyl-1,2-dihydroquinoline-2,3-dicarboxylate (**5a**); *general procedure*

To a magnetically stirred solution of triphenylphosphine (0.262 g, 1 mmol) and benzenesulfanilide-2-carboxaldehyde (0.261 g, 1 mmol) in CH_2Cl_2 (3 ml), a mixture of dimethyl acetylenedicarboxylate

(0.142 g, 1 mmol) in CH_2Cl_2 (2 ml) was added dropwise at −10°C over 10 min. The reaction mixture was then allowed to warm up to room temperature and stirred for 24 hr. The solvent was removed under reduced pressure and the residue was crystallized from ethanol (80%). White crystals of **5a** (0.32 g, m.p.: 117–118°C) were collected by filtration.

IR (KBr): ν_{max} = 1740 and 1701 (2 C=O, ester), 1361 and 1162 (SO_2, sulfonamide) cm^{-1}; ^1H NMR ($CDCl_3$): δ = 3.62, 3.82 (6H, 2 s, 2 OCH_3), 6.20 (1H, s, NCH), 7.1–7.8 (9H, m, arom.), 7.25 (1H, s, H of C4) ppm; ^{13}C NMR ($CDCl_3$): δ = 52.25, 52.98 (2 OCH_3), 55.38 (NCH), 124.20, 126.32, 129.00, 131.08, 133.16 (5 CH of quinoline), 126.85, 128.68 (2 CH of benzenesulfonyl, *ortho* and *meta*), 127.13 (CH of benzenesulfonyl, *para*), 126.90, 133.40, 134.38 (3 C of quinoline), 138.04 (*ipso*-C of benzenesulfonyl), 164.59, 168.46 (2 C=O) ppm; MS: m/z (%) = 388.5 (MH^+, 7), 328.4 ($M^+ - CO_2CH_3$, 100), 246.3 ($MH^+ - SO_2Ph$, 22), 156.0 ($MH^+ - 2CO_2CH_3 - C_3H_2$, 5), 77.0 ($C_6H_5^+$, 25), 59.0 ($CO_2CH_3$, 9); $C_{19}H_{17}NO_6S$ (387.41); calc.: C 58.90, H 4.42, N 3.61; found: C 59.2, H 4.5, N 3.7.

Di-tert-butyl N-benzenesulfonyl-1,2-dihydroquinoline-2,3-dicarboxylate (**5b**)

White crystals; m.p.: 99–100°C; yield: 80%; IR (KBr): ν_{max} = 1739 and 1698 (2 C=O ester), 1365 and 1153 (SO_2, sulfonamide) cm^{-1}; ^1H NMR ($CDCl_3$): δ = 1.25, 1.47 (18H, 2 s, 2 ^{t}Bu), 6.05 (1H, s, N-CH), 6.9 (1H, s, H of C4), 7.1–7.9 (9H, m, arom) ppm; ^{13}C NMR ($CDCl_3$): δ = 27.69, 28.02 (CH_3 of 2 ^{t}Bu), 55.99 (N-CH), 81.32, 82.46 (2 C, 2 ^{t}Bu), 126.80, 126.90, 128.47, 128.52, 130.47, 131.16, 133.03, 133.10 (8 CH of quinoline and benzenesulfonyl), 126.60, 127.08, 134.66, 138.37 (4 C), 163.37, 166.71 (2 C=O) ppm; MS: m/z (%) = 472.6 (MH^+, 6), 416.5 ($MH^+ - {}^t$Bu, 12), 370.5 ($M^+ - CO_2{}^t$Bu, 100), 314.3 ($M^+ - CO_2{}^t$Bu $- {}^t$Bu, 60), 77.1 ($C_6H_5^+$, 2), 57.1 (^{t}Bu, 60); $C_{25}H_{29}NO_6S$ (471.57); calc: C 63.68, H 6.20, N 2.97; found: C 64.7, H 6.8 N 3.1.

Dimethyl N-p-toluenesulfonyl-1,2-dihydroquinoline-2,3-dicarboxylate (**5c**)

White crystals; m.p.: 135–136°C; IR (KBr): ν_{max} = 1745 and 1701 (2 C=O, ester), 1380 and 1165 (SO_2, sulfonamide) cm^{-1}; ^1H NMR ($CDCl_3$): δ = 2.32 (3H, s, CH_3), 3.70, 3.86 (6H, 2 s, 2 CH_3O), 6.22 (1H, s, NCH), 7.0–7.9 (8H, m, arom.), 7.25 (1H, s, H of C4) ppm; ^{13}C NMR ($CDCl_3$): δ = 21.46 (CH_3 of tosyl), 52.25, 52.94 (2OCH_3), 55.38 (NCH), 124.20, 126.32, 126.97, 129.00, 129.25, 131.04, 133.32 (7 CH of quinoline and tosyl), 126.72, 127.10, 134.58, 135.32 (4 C), 144.31 (*ipso*-C of CH_3-C_6H_4), 164.63, 168.58 (2 C=O) ppm MS: m/z (%) = 402.5 (MH^+, 2), 343.0 ($MH^+ - CO_2CH_3$, 19), 342.0 ($M^+ - CO_2CH_3$, 100), 246.3 (MH^+ − tosyl, 43), 91.0 (tropylium ion, 2), 59.0 (CO_2CH_3, 43); $C_{20}H_{19}NO_6S$ (401.44); calc.: C 59.84, H 4.77, N 3.49; found: C 59.9, H 4.8, N 3.6

Di-tert-butyl N-p-toluenesulfonyl-1,2-dihydroquinoline-2,3-dicarboxylate (**5d**)

White crystals; m.p.: 131–132°C yield: 85%; IR (KBr): ν_{max} = 1745 and 1698 (2 C=O, ester), 1365 and 1165 (SO_2, sulfonamide) cm^{-1}, ^1H NMR ($CDCl_3$): δ = 1.30, 1.55 (18H, 2 s, 2 ^{t}Bu), 2.30 (3H, s, CH_3), 6.00 (1H, s, N-CH), 6.92 (1H, s, H of C4), 6.9–7.9 (8H, m, arom) ppm; ^{13}C NMR ($CDCl_3$): δ = 21.38 (CH_3 of tosyl), 27.69, 28.00 (CH_3 of 2 ^{t}Bu), 55.95 (N-CH), 81.20, 82.34 (2C, 2 ^{t}Bu), 126.60, 126.89, 127.00, 128.47, 129.15, 130.39, 131.28 (7 CH of quinoline and tosyl), 126.95, 129.05, 134.80, 135.64 (4 C), 143.83 (*ipso*-C of CH_3-C_6H_4), 163.41, 166.79 (2 C=O) ppm; MS: m/z (%) = 486.6 (MH^+, 5), 430.5 ($MH^+ - {}^t$Bu, 12), 384.0 ($M^+ - CO_2{}^t$Bu, 100), 328.0 ($M^+ - CO_2{}^t$Bu $- {}^t$Bu, 31), 77.1 ($C_6H_5^+$, 2), 57.1 (^{t}Bu, 56); $C_{26}H_{31}NO_6S$ (485.60); calc.: C 64.31, H 6.43, N 2.88; found: C 64.0, H 6.6, N 3.01.

References

[1] Jones G (1977) Qninolines. Wiley-Interscience, London
[2] Hepworth JD (1984) In: Katritzky AR, Rees CW (eds) Comprehensive Heterocyclic Chemistry, vol **2**. Pergamon Press, Oxford, pp 165–524
[3] Schmid H, Karrer P (1979) Helv Chim Acta **32**: 960
[4] Elderfield R, Wark B (1962) J Org Chem **27**: 643
[5] Minter DE, Stoter PL (1981) J Org Chem **46**: 3965
[6] Huckel W, Hagedorn L (1957) Ber **90**: 752
[7] Collins RF (1960) J Chem Soc 2053
[8] Yavari I, Ramazani A (1996) J Chem Res (S) 382
[9] Yavari I, Ramazani A, Yahya-Zadeh A (1996) Synthetic Commun **26**: 4495
[10] Beker KB (1980) Tetrahedron **36**: 1717
[11] Zbiral E (1974) Synthesis 775
[12] Schweizer EE, Smuker LD (1966) J Org Chem **31**: 1717
[13] Furniss BS, Hanaford AJ, Rogers V, Smith PWG, Tatchell AR (1989) Vogel's Textbook of Practical Organic Chemistry, 5th edn. Longman, London, p 590
[14] Williamson KL (1989) Macroscale and Microscale Organic Experiments, D. C. Heath and Company, Lexington, Massachusetts, p 287

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