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Mendeleev Commun., 2007, **17**, 51
Mendeleev Communications

Synthesis of substituted 2-hydroxyaryl aldehydes by the microwave-induced Reimer–Tiemann reaction

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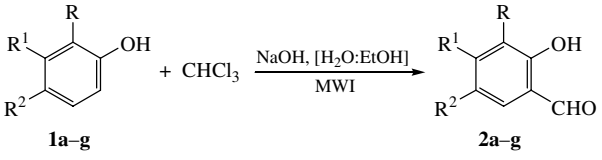
DOI: 10.1016/j.mencom.2007.01.020

A manipulatively simple and rapid method for the synthesis of substituted 2-hydroxy arylaldehydes by the Reimer–Tiemann reaction under microwave irradiation is described.

2-Hydroxyaryl aldehydes are useful intermediates in the synthesis of biologically active coumarins, chalcones, flavones, flavanones, flavanols and Schiff bases, as well as heterocycles like pyrazolines, pyrimidines, 1,5-benzothiazepines, 2-azetidinones and 4-thiazolidinones. We report herein a very simple, fast and general procedure for the formylation of substituted phenols using aqueous alcoholic sodium hydroxide and chloroform under microwave irradiation, which leads to corresponding 2-hydroxyaryl aldehydes. The reactions were normally completed within 25 min without steam distillation, and the yield was improved as compared to a conventional method.[1,2]

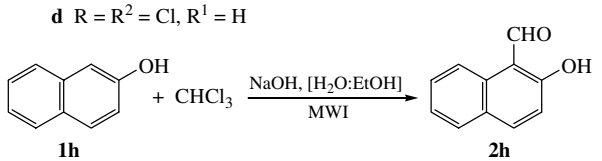
For the synthesis of 2-hydroxyaryl aldehyde by the Reimer–Tiemann reaction according to a normal method, a mixture of phenol, aqueous sodium hydroxide and chloroform was heated at 60–70 °C for 45 min and then for 1 h by keeping in a boiling water bath for completion of the reaction. Then, an excess of chloroform from alkaline solution was removed by steam distillation. The reaction mixture was cooled, acidified and steam distilled to get 2-hydroxyaryl aldehyde in the distillate in 33% yield.

However, when the reaction was carried out under microwave activation, 2-hydroxyaryl aldehydes **2** were obtained in 50–60% yields (Scheme 1).† The structures of the synthesised aldehydes were confirmed by their melting points and spectral data (^{1}H NMR). The products were pure and further purification was not needed. The time required was very short (25 min) as compared to a normal method (4 h), and the energy efficiency was increased.



1a–g **2a–g**

a R = R^1 = H, R^2 = Cl
b R = Cl, R^1 = R^2 = H
c R = R^1 = H, R^2 = Br
d R = R^2 = Cl, R^1 = H
e R = H, R^1 = Me, R^2 = Cl
f R = R^1 = H, R^2 = Ph
g R = R^1 = R^2 = H



1h **2h**

Scheme 1

We are grateful to UGC, New Delhi, India for sanctioning Major Research Grant and the Director, IICT, Hyderabad for providing spectral data. We are also grateful to Dr. N.V. Kalyankar for providing laboratory facilities.

References

1 *Vogel's Textbook of Practical Organic Chemistry*, 4th edn., Longman, London, 1978, p. 761.
2 A. H. Blatt, *Org. Synth. Coll.*, 1955, **3**, 463.
3 R. N. Sen and S. K. Ray, *J. Indian Chem. Soc.*, 1932, **9**, 173.
4 O. S. Kemp, *J. Org. Chem.*, 1971, **36**, 202.
5 B. Auwers, *Ber.*, 1904, **37**, 3934.
6 J. Haruhawa and H. Ishihawa, *J. Pharm. Soc. Jpn.*, 1950, **70**, 338.
7 S. S. Mokle, B. S. Dawane, M. A. Sayyed and Y. B. Vibhute, *J. Chem. Res.*, 2006, 101.

Received: 12th July 2006; Com. 06/2751

† Melting points (uncorrected) were determined in open capillary tubes. The purity of compounds was checked by TLC using silica gel G. The ^{1}H NMR spectra in $CDCl_3$ were recorded on a Perkin-Elmer R-32 spectrometer using TMS as an internal standard.

General procedure for the synthesis of 5-chloro-2-hydroxyaryl aldehyde **2a**. A mixture of 4-chlorophenol **1a** (0.128 g, 1 mmol), dissolved in 8 ml of an aqueous ethanolic (90:10 v/v) solution of sodium hydroxide (0.3 g, 7.5 mmol) and chloroform (0.24 g, 0.16 ml, 2 mmol) was taken in a conical flask capped with a funnel. The flask was placed in a microwave oven (450 W) and irradiated for 40 s six times (total 4 min) with short intervals to avoid the evaporation of chloroform. The reaction mixture was cooled and diluted with 15 ml of aqueous ethanol (90:10 v/v). The solid was filtered off and washed with ethanol. Then, the solid was dissolved in water and acidified using dilute hydrochloric acid to get 5-chloro-2-hydroxybenzaldehyde **2a**.

For **2a**: yield 52%, mp 98 °C (lit.,[3] mp 100 °C). ^{1}H NMR, δ: 11.70 (s, 1H, OH), 9.92 (s, 1H, CHO), 6.87 (s, 1H, 3-H$_{Ar}$), 7.80 (s, 1H, 4-H$_{Ar}$), 7.62 (s, 1H, 6-H$_{Ar}$).

For **2b**: yield 58%, mp 54 °C (lit.,[4] mp 55 °C). ^{1}H NMR, δ: 11.80 (s, 1H, OH), 9.97 (s, 1H, CHO), 7.35 (s, 1H, 4-H$_{Ar}$), 6.96 (s, 1H, 5-H$_{Ar}$), 7.61 (s, 1H, 6-H$_{Ar}$).

For **2c**: yield 60%, mp 103 °C (lit.,[5] mp 105 °C). ^{1}H NMR, δ: 11.03 (s, 1H, OH), 9.92 (s, 1H, CHO), 6.86 (s, 1H, 3-H$_{Ar}$), 7.55 (s, 1H, 4-H$_{Ar}$), 7.85 (s, 1H, 6-H$_{Ar}$).

For **2d**: yield 52%, mp 93 °C. ^{1}H NMR, δ: 11.20 (s, 1H, OH), 10.01 (s, 1H, CHO), 7.65 (s, 1H, 4-H$_{Ar}$), 7.75 (s, 1H, 6-H$_{Ar}$).

For **2e**: yield 57%, mp 79 °C. ^{1}H NMR, δ: 10.85 (s, 1H, OH), 9.95 (s, 1H, CHO), 7.50 (s, 1H, 3-H$_{Ar}$), 7.37 (s, 1H, 6-H$_{Ar}$), 2.30 (s, 1H, Me).

For **2f**: yield 52%, mp 80 °C (lit.,[6] mp 81 °C). ^{1}H NMR, δ: 10.85 (s, 1H, OH), 9.85 (s, 1H, CHO), 6.87 (s, 1H, 3-H$_{Ar}$), 7.50 (s, 1H, 6-H$_{Ar}$).

For **2g**: yield 62%, bp 197 °C (lit.,[1,7] bp 197 °C). ^{1}H NMR, δ: 11.12 (s, 1H, OH), 9.88 (s, 1H, CHO), 6.92–7.64 (s, 4H, H$_{Ar}$).

The synthesis of 2-hydroxynaphthalene-1-carbaldehyde **2h** was performed by the above procedure using 8 ml of 40% aqueous ethanol (40:60 v/v) from 2-naphthol. Yield 65%, mp 80 °C (lit.,[1,7] mp 81 °C). ^{1}H NMR, δ: 13.02 (s, 1H, OH), 10.69 (s, 1H, CHO), 7.08 (s, 1H, 3-H$_{Ar}$), 7.90 (s, 1H, 4-H$_{Ar}$), 7.73 (s, 1H, 5-H$_{Ar}$), 7.41 (s, 1H, 6-H$_{Ar}$), 7.59 (s, 1H, 7-H$_{Ar}$), 8.25 (s, 1H, 8-H$_{Ar}$).