# $SiO_2$ Catalyzed Henry Reaction : Microwave Assisted Preparation of 2-Nitroalkanols in Dry Media

H. M. Sampath Kumar,* B. V. Subba Reddy, and J. S. Yadav
*Organic Chemistry Division-I, Indian Institute of Chemical Technology, Hyderabad-500 007, India*

(Received February 23, 1998; CL-980132)

Nitroalkanes undergo rapid addition to aromatic aldehydes (Henry reaction) on the surface of activated $SiO_2$, when irradiated with microwave, to afford 2-nitroalkanols in moderate to high yields.

Henry nitroaldol addition is an important C-C bond forming reaction, which has been studied extensively and applied in many organic synthesis.[1] Classical methods for this important reaction involve organic and inorganic bases,[2] ammonium acetate, potassium fluoride crown ethers etc., as catalysts and the reaction is generally carried out in an organic solvent.[2] However, since these basic reagents serve as equally good catalysts for aldol and Cannizzaro reactions, whenever aldehydes are used as carbonyl substrates, it is necessary to suitably alter the reaction conditions to suppress these undesirable competitive reactions.[3] Further, initially formed 2-nitroalchols readily undergo base catalysed elimination of water to generate nitroolefins, which inturn are susceptable to polymerisation. It is difficult to avoid the formation of elimination byproduct whenever aromatic aldehydes are employed.[4] Thus, careful control of basicity of the reaction medium is crucial for achieving better yields of nitroalcohols and such efforts demand longer reaction times. Several modifications & improvements in Henry reaction have been reported by Rosini, Ballini and others following nonconventional approaches[6] utilizing alumina, alumina-KF, amberlyst and TBAF as catalysts and olefins were obtained, whenever aromatic aldehyde such as furyl aldehyde was employed.[4] Recently Verma et al., reported microwave promoted Henry reaction catalysed by ammonium acetate in which nitroolefins were isolated as sole products.[8]

Surface mediated solid phase reactions involving microwave activation are gaining importance owing to the advantages & environmentally friendly processes they offer, when compared to conventional reaction conditions.[7] The significance of 2-nitroalkanols in organic synthesis and our continued interest on the microwave promoted dry reactions involving inorganic solid supports,[9] prompted us to explore a suitable method for rapid condensation of nitroalkanes with aromatic aldehydes to afford 2-nitroalchols in good yields. We report here, a convenient and quick, new heterogeneous method for the effective synthesis of 2-nitroalkanols from nitroalkanes and aromatic aldehydes on $SiO_2$ surface, promoted by microwave, under solvent free conditions.

Nitroalcohols (3a-j) were isolated in good yields when a mixture of aromatic aldehydes (10 mmol; 1a-j) and nitroalkanes (10 mmol) adsorbed on $SiO_2$ (finer than 200 mesh, 5 g) and taken in a open pyrex test tube was subjected to microwave irradiation in a domestic microwave oven (BPL, BMO 700T) at an out put of about 600 watts. After cooling the reaction mass to room temperature, the products were isolated by extracting with dichloromethane and evaporation of the solvent in vacuo. The catalyst recovered during workup, could be effectively reused, after activation. The reactions were generally clean and unreacted starting compounds being the only other components of the reaction mixture after irradiation, which were separated by column chromatography whenever necessary.

**Scheme.**

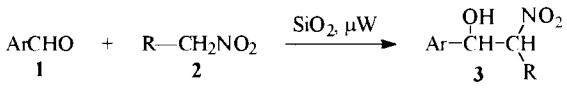
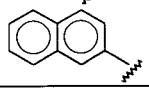



**Table.** Microwave assisted preparation of 2-nitroalkanols in dry media

| | Ar | R | Reaction Time (min )[b] | Yield (%)[c] |
|---|---|---|---|---|
| 3a. | $C_6H_5$ | $CH_3$ | 5 | 75 |
| 3b. | $C_6H_5$ | H | 4 | 71 |
| 3c. | 4-$NO_2C_6H_4$ | $CH_3$ | 4 | 82 |
| 3d. | 4-$NO_2C_6H_4$ | H | 4 | 79 |
| 3e. | 4-$CH_3C_6H_4$ | $CH_3$ | 4 | 70 |
| 3f. | 4-$ClC_6H_4$ | $CH_3$ | 4 | 81 |
| 3g. | 4-$BrC_6H_4$ | $CH_3$ | 4 | 70 |
| 3h. |  | $CH_3$ | 4 | 73 |
| 3i. |  | $CH_3$ | 3 | 56 |
| 3j. |  | $CH_3$ | 4 | 66 |

a : All products were characterised by IR, & $^1H$ NMR spectroscopy.

b : Microwave irradiation was carried out in pulse of 1 minute duration (with 30 sec intervel) each time at power level of about 600 watts.

c : Yields of isolated 2-nitroalkanols after column chromatography.

However, 2-nitroolefin derived from dehydration of 2-nitroalcohol (3i) was isolated as by product (17% yield) incase of furyl aldehyde (1i). Further, it is important to mention that, when alumina was used as catalyst instead of $SiO_2$, a mixture of 2-nitroalcohol and nitroolefin (elimination byproduct) was isolated even under milder conditions of power and time of irradiation. Microwave induced rate enhancement during Henry

reaction was unequivocally established, as this condensation proceeds only to a minor extent (2-5%, 2 hours) when the reactions were repeated under conventional heating conditions using oil bath preheated to 110° (highest observed temperature at the end of microwave irradiations). Further, no product could be detected even after 24 hours, when these reactions were attempted at room temperature.

In conclusion the microwave promoted Henry reaction involving condensation of aromatic aldehydes with nitroalkanes on $SiO_2$ surface presented in this paper is a convenient, quick and clean method for the preparation of 2-nitroalkanols in good yields.

**References**


1 D. Seebach, E.W. Colrin, F. Lener, and T. Weller, *Chimia*, **33**, 1 (1979). G. Rosini, in "Comprehensive Organic synthesis," ed by B.M. Trost, Pergamon Press, Oxford (1991), Vol. 2, p. 321. R. Rosini and R. Ballini, *Synthesis*, **1988,** 833 and the references cited therein.

2 R. Ballini, G. Bosica, and P. Forconi, *Tetrahedron*, **52**, 1677 (1996), and the references cited therein; S.N. Karmarkar, S.L. Kelkar, and M.S. Wadia, *Synthesis*, **1985**, 510.

3 B.M. Vander Biet and H.B. Hass, *Ind. Eng. Chem.*, **32,** 34 (1940). H.B. Hass and E.F. Riby, *Chem. Rev.*, **32,** 373 (1943). F.W. Lichtenthaley, *Angew. Chem., Int. Ed. Engl.*, **3**, 211 (1964). V. Costantino, M. Curini, F. Mormottini, O. Rosati, and E. Pisani, *Chem. Lett.*, **1994**, 2215.

4 B.P. Bandagar, M.B. Zirange, and P.P. Wandgaokar, *Synlett*, **1996**, 149. G. Bosin, R. Ballini, M. Petrini, and P. Sorrenti, *Synthesis*, **1985**, 515.

5 G.W. Kabalka and R.S. Varma, *Org. Prep. Proc. Int.*, **19**, 283 (1987). C.D. Hurd and M.E. Nilson, *J. Org. Chem.*, **20**, 927 (1955). G. Rosini, R. Ballini, P. Sorronti, and M. Petrini, *Synthesis*, **1984**, 607. Idem. *Org. Prep. Proc. Int.*, **22**, 707 (1990).

6 G. Rosini, R. Ballini, and P. Sorrenti, *Synthesis*, **1983**, 1014. S. Hanessian and P.V. Devasthale, *Tetrahedron Lett.*, **37**, 987 (1996). J.M. Melot and F.T. Boullet, *Tetrahedron Lett.*, **27**, 493 (1986).

7 A. McKillop and D.W. Young, *Synthesis*, **1979**, 401. R.A. Abramovich, *Org. Prep. Proced. Int.*, **23**, 683 (1991). S. Caddick, *Tetrahedron*, **51,** 10403 (1996). S.A. Galema, *Chemical Soc. Rev.*, **26**, 233 (1997).

8 R.S. Varma, R. Dahiya, and S. Kumar, *Tetrahedron Lett.*, **38**, 5131 (1997).

9 H.M. Sampath Kumar, P.K. Mohanty, M.S. Kumar, and J.S. Yadav, *Synth. Commun.*, **27**, 1327 (1997).


IICT Communication No. 3902.