ISSN: 0974 - 7516 Volume 11 Issue 9

Organic CHEMISTRY

An Indian Journal

Full Paper

OCAIJ, 11(9), 2015 [319-322]

Microwave –induced an efficient synthesis of β-enaminones using boric acid as catalyst under solvent-free condition

Balasaheb V.Shitole[1], S.D.Soluke[2], Nana V.Shitole[2], Gopal K.Kakde[3]*

[1]Department of Chemistry, Vasant College Kaij-431518, (INDIA)

[2]Rajarshi Shahu college Latur-413512, (INDIA)

[3]Shri Shivaji College, Parbhani-431401 (M.S), (INDIA)

[4]Arts, Commers and Science College, Dharur(Kille)-431519, (INDIA)

E-mail: kakdeg44 @gmail.com

ABSTRACT

An efficient and simplified protocol for boric acid catalyzed solvent-free synthesis of β-enaminones derivatives under microwave irradiation is described. The remarkable advantages offered by this method are inexpensive and readily available catalyst, simple procedure, faster reactions and high yield of products.

KEYWORDS

Boric acid;
β-enaminones;
Microwave irradiation;
Green chemistry.

INTRODUCTION

Nitrogen containing organic compounds are of special interest because they constitute an important class of natural and non-natural products, many of which exhibit useful biological activities. Among those compounds, β-enaminones have been employed as synthetic building block of a wide veriety of heterocycles,[1] key intermediate in synthesis of different heterocycles and naturally occouring alkaloids[2] and in pharmaceuticles[3]. In addition, chiral enaminones obtained from optically active compounds are useful ligand for diastereoselective synthesis[4].

The most well-known and exploited route for the synthesis of β-enaminones involves the direct condensationof 1,3-dicarbonyl compounds with amines in refluxingaromatic hydrocarbons with azeotropic removal of water[5]. Some improved procedures have been subsequently reported for this transformation using different catalysts like Sc(OTf)3[6], $Bi(OTf)_3$[7], Au,[8] $Zn(OAc)_2.2H2O$,[9] silica[10] Although, these approaches are satisfactory for synthesis of enaminones, the harsh reaction conditions, expensive reagents, use of toxic organic solvents and long reaction times limit the use of these methods. Thus, the development of a new method for the synthesis of β-Enaminones would be highly desirable.

In recent years, boric acid have gained special attention a catalyst in organic synthesis because many advantages such as uncomplicated handling, inexpensiveness and eco-friendly nature. Recently, it is evident from the literature that boric acid has invoked enormous interest as a green and potential catalyst to construct carbon-carbon and carbon–heteroatom bonds in various organic transformations such as aza-Michael reaction[11] transesterification

of ethyl acetoacetate[12], oxidation of sulfides[13], Biginelli reaction[14], and Mannich reaction[15].

EXPERIMENTAL

Apparatus and reagents

All amine were obtained from freshly opened container and used without further purification. Melting points were determined in open capillary tubes in a paraffin bath. The progresses of the reactions were monitored by TLC (Thin Layer Chromatography). IR spectra were recorded on Perkin-Elmer FT spectrophotometer in KBr disc.^{1}H NMR spectra were recorded on an 400 MHz in $CDCl_3$ as a solvent and chemicalshift values are recorded in units δ (ppm) relative to tetramethylsilane (Me4Si) as an internal standard.

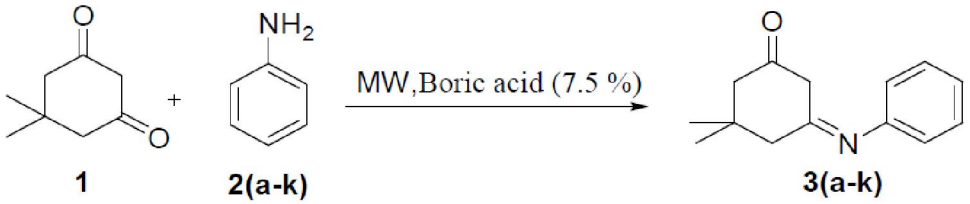
General procedure for the synthesis β-Enaminones

A mixture of aromatic amines (1 mmol), dimedone (1mmol) and boric acid (7.5 mole %) were taken in a beaker. The reaction mixture homogenized with the help of glass rod and irradiated in microwave oven (400 W) by the interval of 10 second. The progress of reaction was monitored on TLC. After completion of the reaction, mixture was cooled to room temperature and poured on crushed ice. Thus, solid obtained was filtered, dried and purified by crystallization in ethanol.

RESULT AND DISCUSSION

In continuation of our work concerning the synthesis and biological evaluation of new heterocycles here we wish to report a very simple, fast and general method for the synthesis of β-enaminones (3a-k) in the presence of catalytic amount of boric acid under microwave at.400W and solvent-free conditions (Scheme 1) considered as a standard model reaction. Initially, we examined the reaction without catalyst at different power for 10 min did not result in formation of the expected product Show in TABLE 1. To determine the appropriate concentration of the catalyst boric acid (7.5mol %) we investigate the model reaction dimedone, aniline and boric acid (7.5 mol %) under solvent free condition. The reaction mixture was irradiated in microwave oven at different power for appropriate time. The corresponding product was obtained in excellent yield (TABLE 1).

To determine the optimum concentration of cata-



Scheme 1

TABLE 1 : Optimization of catalyst amount in synthesis of β-enaminones derivatives under microwave irradiation

Entry	Power	(Mol %)	Time (min)b	Yield (%)c
1	100	Without	10	No reaction
2	180	Without	10	No reaction
3	300	Without	10	No reaction
4	450	Without	10	No reaction
5	600	Without	10	No reaction
6	100	7.5	7	75
7	180	7.5	6	83
8	300	7.5	5	87
9	450	7.5	4	91
10	600	7.5	4	91

TABLE 2 : Effect of concentration of boric acid

Entry	Concentration (mol%)	Yield (%)
1	2.5	47
2	5	72
3	7.5	91
4	10	91

TABLE 3 : Synthesis of β-Enaminones (3a-j) using (10 mol %) boric acid as catalyst[a]

Entry	Compound	Ar-NH2	Time (min)	Yield (%)[b]	M.P.(°C)
1	3a	C_6H_5	4	91	182-184
2	3b	4-NO_2-C_6H_4	10	90	194-195
3	3c	4-Cl-C_6H_4	6	91	191-192
4	3d	4-Br-C_6H_4	6	90	164-166
5	3e	4-Me-C_6H_4	4	96	144–146
6	3f	2-Me-C_6H_4	4	89	135-137
7	3g	3-Me-C_6H_4	5	87	139-141
8	3h	4-EtO-C_6H_4	5	94	110-112
9	3i	4-F-C_6H_4	4	92	190-192
10	3j	2,3-Cl-C_6H_4	5	96	200–201
11	3k	4-MeO-C_6H_4	6	89	107-109

[a] Reaction conditions:- 1 (1 mmol), 2 (1 mmol), catalyst (7.5 mol%) [b] Isolated yield.

lyst, we have investigated the model reaction at 2.5,5, 7.5 and 10 mol% of boric acid. The product was obtained in 47, 72, 91 and 91% yield, respectively. This indicates that the use of 7.5 mol% of boric acid is sufficient to promote the reaction forward (TABLE 2).

To study the generality of this process, variety of examples were illustrated for the synthesis of β-enaminones and results are summarized in TABLE 3. The reaction is compatible for various substituents such as CH_3, OCH_3, OH, $N(CH_3)_2$, Cl and F. This method is also effective for the heteroaromatic aldehydes which form their corresponding β-enaminones in excellent yields(TABLE 3). The formation of desired product was confirmed by ^1H NMR, IR and mass spectroscopic analysis technique.

Spectral data of the the principal products

(Z)-3,3-dimethyl-5-(phenylimino)cyclohexanone (3a) ^1H NMR ($CDCl_3$) δ ppm, 1.2 (S, 6H, 2 x CH_3), 2.2 (s, 2H, C-CH_2), 2.4 (s, 2H, $COCH_2$), 5.6 (s, 1H, CH), 7.1-7.4.0 (m, 5H, Ar-H), 7.8 (s, 1H, NH); m/z 216 (M^+), 215(M^-).

(Z)-5-(4-bromophenylimino)-3,3-dimethylcyclohexanone (3d) ^1H NMR ($CDCl_3$ δ ppm, 1.02 (s, 6H 2x CH_3), 2.14 (s, 2H C-CH_2), 2.36 (s, 2H $COCH_2$), 5.13 (s, 1H CH), 6.66(br., 1H), 6.96 (d, 2H, Ar-H), 7.39 (d, 2H, Ar-H) m/z 293 (M^+), 295 (M^-).

CONCLUSION

In conclusion, we have developed efficient and environmentally benign methodology for the synthesis of β-enaminones derivatives by a one-pot, multi-component reaction. The advantages of this method over other existing methods are reduced reaction times, higher yields, mild reaction condition, easy purification and economic viability of the catalyst. We feel that this economically viable procedure will find practical utility for the one pot synthesis of novel xanthenes.

ACKNOWLEDGEMENTS

We are thankful to the University Grants Commission, New Delhi, for financial support which is gratefully acknowledged and the Sophisticated Analytical Instrument Facility, Punjab University, Chandigarh for providing spectroscopic data.

Full Paper

REFRENCES

[1] C.Alan, A.C.Spivey, R.Sirikaran, C.M.Diaper, J.David, D.Turner; Org.Biomol.Chem., 1638 **(2003)**.

[2] **(a)** J.D.White, D.C.Lhle; Org.Lett., **8**, 1081 **(2006)**; **(b)** G.Li, K.Watson, R.W.Buckheit, Y.Zhang; Org.Lett., **9**, 2043 **(2007)**; **(c)** C.Kappe; Angew.Chem.Int.Ed., **43,** 6250 **(2004).**

[3] M.Abass, B.B.Mostafa; Bioorg.Med.Chem., **13**, 6133 **(2005)**; **(b)** I.O.Edafiogho, K.V.Ananthalakshmi, S.B.Kombian; Bioorg.Med.Chem., **14**, 5266 **(2006); (c)** I.O.Edafiogho, O.A.e, E.E.Udo, S.Samuel, B.Rethish; Eur.J.Med.Chem., **44**, 967 **(2009)**.

[4] S.A.Popov,Y.V.Gatilov, T.V.Rybalova, A.V.Tkachev; Tetrahedron Assymetry, **14**, 233 **(2003)**; **(b)** S.A.Popov, A.V.Tkachev; Synth.Commun., **31**, 233 **(2001).**

[5] G.Palmieri, C.Cimarelli; Arkivoc, **6**, 104 **(2006).**

[6] J.S.Yadav, V.N.Kumar, R.S.Rao, A.D.Priyadarshini, P.P.Rao, B.V.S.Reddy, K.Nagaiah; Journal of Molecular Catalysis, **56**, 234 **(2006)**.

[7] A.R.Khosropour, M.M.Khodaei, M.Kookhazadeh; Tetrahedron Lett., **45**, 1725 **(2004).**

[8] A.Arcadi, G.Bianchi, S.D.Giuseppe, F.Marinelli; Green Chemistry, **5**, 64 **(2003)**

[9] R.K.Vohra, J.L.Renaud, C.Bruneau; Synthesis, **5**, 0731(**2007).**

[10] B.Rechsteiner, T.B.Francoise, J.Hamelin; Tetrahedron Lett., **34**, 5071 **(1993).**

[11] M.K.Chaudhuri, S.Hussain, M.L.Kantam, B.Neelima; Tetrahedron Lett., **46**, 8329 **(2005).**

[12] G.C.M.Kondaiah, L.A.Reddy, K.S.Babu, V.M.Gurav, K.G.Huge, R.Bandichhor, P.P.Reddy; Tetrahedron Lett., **49**, 106 **(2008).**

[13] A.Rostami, J.Akradi; Tetrahedron Lett., **51**, 3501 **(2010)**.

[14] S.Tu, F.Fang, C.Miao, H.Jiang, Y.Feng, Y.Shi, X.Wang; Tetrahedron Lett., **44**, 6153 **(2003).**

[15] C.Mukhopadhyay, A.Datta, R.J.Butcher; Tetrahedron Lett., **50**, 4246 **(2009).**