Heterocyclic Letters
Vol. 6| No.2|223-227| Feb-April| 2016
ISSN : (print) 2231–3087 / (online) 2230-9632
CODEN: HLEEAI
http://heteroletters.org

YTTRIUM TRIFLATE MEDIATED ACETYLATION OF AMINES AND PHENOLS UNDER SOLVENT-FREE CONDITIONS

D Veena[b], V Daniel[a], K Santosh kumar[b], N Rameshwar[a*]

[a] *Department of Pharmaceutical chemistry, Telangana University, Nizamabad, India*
[b] *Department of Chemistry, Osmania University, Hyderabad 500 007, India*
**E-mail:* rameshwarnimma@gmail.com

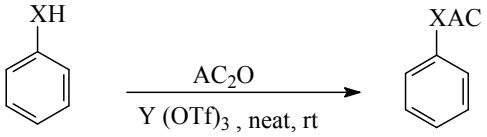
Abstract
A wide variety of amines and phenols were efficiently and selectively converted to their corresponding acetates by treatment with acetic anhydride in the presence of 0.5 mol percent of catalytic amounts of Yttrium triflate under solvent-free conditions at room temperature. This reaction requires the lowest catalyst quantity and relatively short reaction time compared to previous studies.

Keywords: Acetic anhydride, Acetylation, Solvent-free, Yttrium triflate.

Introduction

The acetylation of amines, alcohols phenols is an important chemical reaction in organic synthesis[i]. Acid anhydrides have been the most commonly used reagents in the presence of an acid or base catalyst[ii]. Among the basic catalysts, Bu_3P[iii], $MgBr_2$-R_3N[iv] and acid catalyst such as Gd $(OTf)_3$, immobilized ionic liquid[v], $HClO_4$-SiO_2[vi], AC_2O-Py/basic alumina[vii], $NiCl_2$[viii], $RuCl_3$[ix], $InCl_3$[x], $ZrCl_4$[xi], $LiClO_4.2H_2O$[xii], $NaHSO_4$-SiO_2[xiii], zeolite[xiv] and Nafion-H[xiii-xv] have been reported. Most of them require drastic conditions and long reaction times[vi].

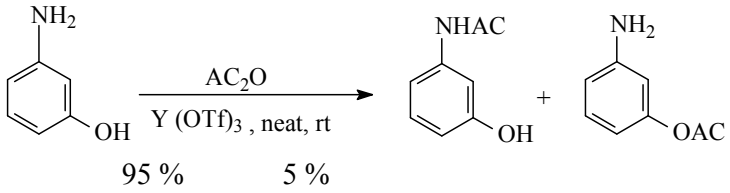
Recently, there has been growing considerable interest in the use of triflates in organic synthesis[xvi]. The strong Lewis acid character of the triflates make their use for acid sensitive substrates difficult necessitating the use of an acylating agent and carrying out the reaction at low temperature to avoid potential side reactions. Here in we report the acetylation of amines, phenols and bifunctional amino phenolic compounds with acetic anhydride in the presence of 0.5 mol % yttrium triflate at room temperature under solvent-free condition as shown in the (Scheme-1).



Scheme 1. Acetylation of amines and phenols.

Results and discussion

We have developed a convenient acetylation between aromatic amines/phenols and acetic anhydride in the presence of catalytic amount of yttrium triflate. When aniline treated with acetic anhydride in the presence of 0.5 mol % of yttrium triflate at room temperature under solvent-free conditions turbidity appeared and a white solid precipitated out within a minute. The yield was 96%. The compound was extracted in to ethyl acetate and neutralized with sodium bicarbonate. The organic layer was dried over anhydrous sodium sulfate. It has shown a single spot in TLC, m.p-114°C. Similar acetylation reactions were carried out with different amines, phenols and bifunctional amino phenolic compound with acetic anhydride in the presence of catalytic amount of yttrium triflate. The time taken for the completion of the acetylation and yield are given in Table-1. The m.p, NMR and MASS spectra were in agreement with the literature data. Examination of the (Table -1) shows that acetylation on nitrogen in the amines is efficient and faster than on oxygen in phenols. When the amino and phenolic hydroxylic groups are present in a reactant (entry 13) the acetylation selectively occurred on nitrogen giving the corresponding anilide as a major product (95%) and the corresponding O-acetylated ester as minor product (5%) (Scheme-2). Annulated bicyclic and tricyclic systems acetylated slowly than the monocyclic systems. Acetylation of 2-amino anthracene occurred slowly than that of aniline while acetylation of 2-naptholproduced slowly than that of phenol.



Scheme 2. Acetylation of 3-aminophenol.

Conclusion

The present yttrium triflate catalyzed procedure provides an efficient and improved method for the acetylation reactions. It is an important supplement to the existing methods of acetylation under solvent-free, mild conditions with high yields in short reaction times. This method has also been found to have the ability to tolerate a wide variety of substituents.

Experimental

Melting points were determined on a Polomon melting point apparatus (model no.M.P-96) and are uncorrected. ^{1}H NMR spectra were recorded in $CDCl_3$ employing Bruker 400 MHz spectrometer using TMS as an internal standard. Mass spectra were recorded on VG Micro mass 7070 H spectrometer operating at 70eV.

General procedure for the synthesis of acetyling compounds

To a mixture of amine (1 mmol) and acetic anhydride (1.2 mmol) was added finely powdered yttrium triflate (0.05 mmol) and the reaction mixture was stirred under solvent-free conditions at room temperature for an appropriate time (Table-1). After completion of the reaction as monitored by TLC, water was added to the reaction mixture and the product was extracted in to ethyl acetate (3X15ml). The combined organic layer was washed with brine, the organic layer was dried over anhydrous sodium sulfate and concentrated under reduced pressure to give a pure product. Entry 2 was purified by column chromatography on silica gel in hexane/ethyl acetate.

Spectral data for selected compounds

N-phenyl acetamide **(1)**. m.p 114°C, ^{1}H NMR (400 MHz, $CDCl_3$) δ: 2.15 (s, 2H), 7.10 (m, 1H), 7.28 (m, 2H), 7.50 (d, 2H), 8.20 (broad s, 1H). ^{13}C- NMR ($CDCl_3$) δ: 24.1, 120.1, 124.2, 128.8, 138.0, 168.2. EIMS: m/z (%) 136 (82) $[M+H]^+$.

N-(2-methoxy-phenyl)-acetamide **(2)**. m.p 125°C, ^{1}H NMR (400 MHz, $CDCl_3$) δ: 2.19 (s, 3H), 3.87 (d, 3H), 6.85 (d, 1H), 6.94 (m, 1H), 7.03 (m, 1H), 7.70 (broad s, NH), 8.35 (d, 1H). ^{13}C- NMR ($CDCl_3$) δ: 24.5, 55.6, 110.1, 120.1, 121.1, 123.5, 127.3, 147.1, 168.0. EIMS: m/z (%) 166 (95) $[M+H]^+$.

N-(2,4-dichloro-phenyl)-acetamide **(11)**. m.p 213°C, ^{1}H NMR (400 MHz, $CDCl_3$) δ: 2.23 (s, 3H), 7.23 (dd, 1H), 7.36 (d, 1H), 7.60 (broad s, NH), 8.30 (d, 1H). ^{13}C- NMR ($CDCl_3$) δ: 24.3, 122.6, 123.9, 127.8, 128.6, 129.2, 133.5, 167.8. EIMS: m/z (%) 203 (90) $[M+H]^+$.

Acknowledgements

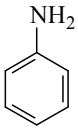
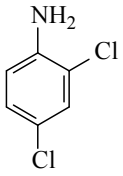
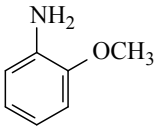
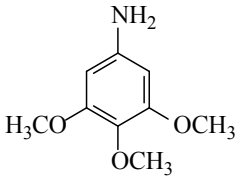
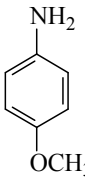
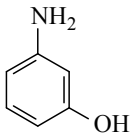
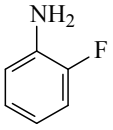
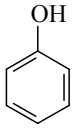
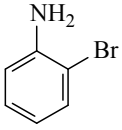
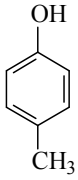
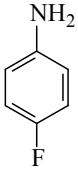
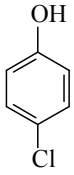
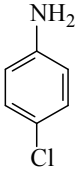
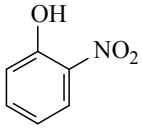
One of the authors (DV) is thankful to the Head, Department of chemistry, Osamania University, Hyderabad and Director, Central facilities, Osmania University, Hyderabad, India, for providing spectral data.

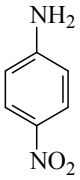
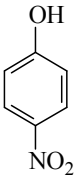
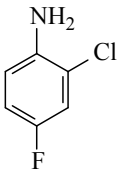
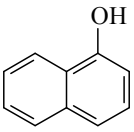
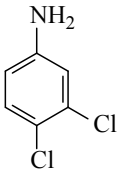
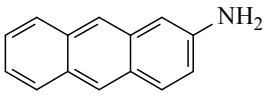
References

i. Greene, T. W. ; Wuts, P. G. M.; Protective Groups in Organic Synthesis, 4Th edn, wiley, New York, 223, (2007).
ii. Larock, R. C.; Comprehensive Organic Transformations, VCH Publishers: New York, 980, (1989).
iii. Vedejs, E.; Diver, S. J. Ame. Che. Soc. 115, 3358, (1993).
iv. Vedejs, E.; Daugulis, O. J. Org. Chem. 61, 5702, (1996).
v. Alleti, R. O.; Perambudura, M.; Afrasiabi, Z.; Sinn, E.; Reddy, V. P. Green Chemistry, 7, 203, (2005).
vi. Chakraborti, A. K.; Gulhane, R. Chem. Commun. 1896, (2003).
vii. Paul, S.; Nanda, P.; Gupta, R.; Loupy, A.; Tetrahedron Lett. 43, 4261, (2002).
viii. Constantinon-Kokotoo, V.; Peristeraki, A. Synth. Commun. 34, 4227, (2004).
ix. De, S. Tetrahedron Lett. 4, 2919, (2004).
x. Chakraborti, A. K.; Gulhane, R. Tetrahedron Let. 44, 3521, (2003).
xi. Chakraborti, A. K.; Gulhane, R. Synlett, 657, (2004).
xii. Nakae, Y.; Kusaki l.; Sato, T. Synlett, 1584, (2001)**.**
xiii. V. Das, P. Thirupathi, J. Mol. Catal. A: Chem. 12, (2007), 269.
xiv. Baliini, R.; Bosica, G.; Carloni, S.; Ciaralli, L.; Maggi, R.; Sartori, G. Tetrahedron Lett. 39, 6049, (1998).
xv. Kumareswaran, R.; Pachamuthu, K.; Vankar, Y. D. Synlet. 1652, (2000).
xvi. Kobayashi, S. Eur. J. Org. Chem. 15, (1999).

Received on February 1, 2016

Table 1.
Acetylation of amines and phenols using AC_2O in the presence of Yttrium triflate as a catalyst*

Entry	Substrate	Time# (min)	Yield (%)a	Entry	Substrate	Time# (min)	Yield (%)a
1		1	96	11		6	92
2		3	95	12		7	90
3		5	94	13		9	95
4		12	93	14		1	95
5		8	94	15		5	91
6		10	95	16		4	92
7		5	94	17		12	90

8		8	89	18		10	89
9		8	90	19		15	93
10		3	95	20		18	90

* The ^{1}H & ^{13}C NMR and MASS spectral data of the pure products were identical to those of the authentic samples.
# Reaction time (min)
[a]Isolated yield

.