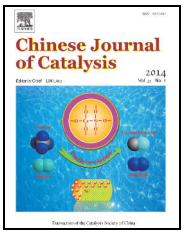
Chinese Journal of Catalysis 35 (2014) 58–65

available at www.sciencedirect.com

ScienceDirect

journal homepage: www.elsevier.com/locate/chnjc



Article

$H_3PW_{12}O_{40}$ catalyzed synthesis of benzoxazine and quinazoline in aqueous media

Mahmood Tajbakhsh *, Rahman Hosseinzadeh, Parizad Rezaee, Mahgol Tajbakhsh

Department of Organic Chemistry, Faculty of Chemistry, University of Mazandaran, Babolsar, 47415, Iran

ARTICLE INFO

Article history:
Received 5 July 2013
Accepted 4 September 2013
Published 20 January 2014

Keywords:
Heteropoly acid
1,3-Benzoxazine-4-one
2-Substituted-quinazolin-4(3H)-one
2-Substituted-2,3-dihydroquinazolin-4(1H)-one

ABSTRACT

A heteropolyacid efficiently catalyzed the cyclocondensation reaction of 2-aminobenzamide and salicylamide with aldehydes and ketones to afford good yields of benzoxazine and quinazoline ring systems in an aqueous medium. The method gives clean reactions, has simple workup procedure, and uses environment friendly conditions.

1. Introduction

Heteropolyacids (HPAs) are strong Brönsted acids that can catalyze a wide variety of reactions in both homogeneous and heterogeneous phases to offer more efficient and cleaner processes [1–7]. They are effective catalysts in various reactions because their catalytic mechanisms can be diverse at the molecular level [1,2]. Among them, Keggin-type [8] HPAs have long been known to be good catalysts for oxidation reactions [9,10]. Oxazinones constitute an important class of heterocycles, which have attracted much interest due to their wide range of biological activities [11–20]. Oxazinones have also been utilized as useful synthetic precursors for the preparation of organic compounds [21–23]. 2-Substituted 1,3-benzoxazinones can be synthesized from salicylamide and aldehydes using concentrated sulfuric acid [24,25], an amine catalyst in refluxing benzene or toluene [26], *p*-toluenesulfonic acid monohydrate (TsOH) in refluxing toluene [27,28], or a dehydration reaction with polyphosphonate ethyl ester (PPE) in refluxing chloroform [29]. The preparation of 2-aryl-2-trifluoromethyl-2,3-dihydro-4H-1,3-benzoxazine-4-ones using isocyanates and 3-alkoxyphenols in the presence of triethylamine [30] was also reported. Recently, a chiral Brönsted acid was applied for the preparation of 1,3-benzoxazine-4-ones [31]. However, many of these procedures have limitations such as tedious work-up [24–28], toxic solvents [26,28], low yields [24,25,30], long reaction times [30] or/and harsh reaction conditions [24,25]. Therefore, the development of a new catalytic route is an active area of research.

As a new catalytic route, we designed a simple procedure that can be used to synthesize a series of 2,3-dihydro-4H-1,3-benzoxazine-4-ones derivatives. Quinazolines and their derivatives are versatile *N*-containing heterocyclic compounds, which have a broad spectrum of biological and pharmacological activities. Substitution at the 2- and 3-positions of the quinazoline nucleus plays a pivotal role in different activities such as anticancer [32], anti-inflammatory [33], antidiuretic [34], and anticonvulsant [35] activities. 2,3-Dihydroquinazolin-4(1H)-ones

* Corresponding author. Tel/Fax: +98-11253 42302; E-mail: tajbaksh@umz.ac.ir
DOI: 10.1016/S1872-2067(12)60706-2 | http://www.sciencedirect.com/science/journal/18722067 | Chin. J. Catal., Vol. 35, No. 1, January 2014

in particular have good biological activities and are also key intermediates for the synthesis of quinazolin-4(3H)-ones [36,37]. Several methods have been reported for the synthesis of quinazolinone and aryl-substituted quinazolinone compounds [38–66]. The one-pot three-component condensation of isatoic anhydride, aldehydes, and amines is the most convenient method for the preparation of these compounds. Many catalysts have been reported for this reaction [67–76], and although many of these methods are effective, some of them suffer in terms of long reaction times [67], harsh reaction conditions and low yields [69], special effort to prepare the catalyst [77], or/and failure in the reaction with aromatic ketones. As part of our ongoing program to develop new catalysts to promote organic transformations [78–80], we report here the use of $H_3PW_{12}O_{40}$ as an efficient and reusable catalyst for the synthesis of benzoxazine and quinazoline ring systems under very mild conditions.

2. Experimental

All chemicals were obtained commercially from Aldrich or Merck Chemical Co. and used as received. ^{1}H and ^{13}C NMR spectra were recorded on a Bruker DRX-400 AVANCE (400 and 100 MHz for ^{1}H and ^{13}C, respectively) using DMSO-d_6 as solvent. Chemical shifts are reported on the δ scale relative to internal Me_4Si. Melting points (mp) were determined on a Thermo Scientific IA9200 and are uncorrected. Mass spectra were obtained on an Agilent instrument, and infrared (IR) spectra were determined on a Bruker instrument.

2.1. General procedure for the synthesis of 1,3-benzoxazine-4-one derivatives

A mixture of salicylamide (1 mmol), aldehyde (1 mmol), and $H_3PW_{12}O_{40}$ (5 mol%) in water/ethanol (5:1) was heated at 80 °C. The reaction was followed by TLC analysis. After completion of the reaction, the mixture was cooled, the solvent was removed under reduced pressure, and a small amount of water (5 mL) was added to dissolve the catalyst, which was filtered off. Then, the residue was recrystallized with ethanol to get the pure product. The analytical data for selected products were as follows.

2-(3-Bromophenyl)-2H-benzo[e][1,3]oxazin-4(3H)-one (**3c**). mp: 187–189 °C; IR (KBr, cm^{-1}): ν 3175, 3066, 2894, 1682, 1611, 1467, 1279, 1143, 1072; ^{1}H NMR (400 MHz, DMSO-d_6): δ_H (ppm) 9.02 (s, 1H, NH), 7.80 (dd, J = 1.6, 7.8 Hz, 1H, Ar-CH), 7.76 (t, J = 2.0, 1H, Ar-CH), 7.65 (dq, J = 0.8, 8.0 Hz, 1H, Ar-CH), 7.59 (d, J = 7.6 Hz, 1H, Ar-CH), 7.53 (td, J = 1.6, 7.8 Hz, 1H, Ar-CH), 7.43 (t, J = 8.0 Hz, 1H, Ar-CH), 7.14 (td, J = 1.2, 7.6 Hz, 1H, CH), 7.07 (dd, J = 0.8, 8.2 Hz, 1H, Ar-CH), 6.42 (d, J = 1.6 Hz, 1H, CH); ^{13}C NMR (100 MHz, DMSO-d_6): δ_C (ppm) 83.97, 117.28, 118.75, 122.10, 122.93, 126.85, 127.92, 130.57, 131.27, 132.93, 135.09, 139.95, 157.09, 162.82. Analysis Calcd. for $C_{14}H_{10}BrNO_2$: C, 55.29; H, 3.31; N, 4.61. Found: C, 55.19; H, 3.39; N, 4.71.

2-(4-Fluorophenyl)-2H-benzo[e][1,3]oxazin-4(3H)-one (**3d**). mp: 176–178 °C; IR (KBr, cm^{-1}): ν 3189, 3045, 2868, 1687, 1627, 1451, 1263, 1109; ^{1}H NMR (400 MHz, DMSO-d_6): δ_H (ppm) 8.99 (s, 1H, NH), 7.80 (dd, J = 1.6, 8.0 Hz, 1H, Ar-CH), 7.66–7.61 (m, 2H, Ar-CH), 7.53 (td, J = 1.6, 7.6 Hz, 1H, Ar-CH), 7.29 (t, J = 9.2 Hz, 2H, Ar-CH), 7.14 (td, J = 0.8, 7.6 Hz, 1H, Ar-CH), 7.05 (dd, J = 0.8, 8.0 Hz, 1H, Ar-CH), 6.40 (d, J = 1.6 Hz, 1H, CH); ^{13}C NMR (100 MHz, DMSO-d_6): δ_C (ppm) 84.40, 115.76, 115.98, 117.21, 118.76, 122.83, 127.92, 130.16, 130.25, 135.01, 157.29, 163.08, 164.42. Analysis Calcd. for $C_{14}H_{10}FNO_2$: C, 69.13; H, 4.14; N, 5.76. Found: C, 69.21; H, 4.03; N, 5.64.

4-(4-Oxo-3,4-dihydro-2H-benzo[e][1,3]oxazin-2-yl)benzonitrile (**3f**). mp: 219–221 °C; ^{1}H NMR (400 MHz, DMSO-d_6): δ_H (ppm) 9.12 (d, J = 1.6 Hz, 1H, NH), 7.94 (d, J = 8.4 Hz, 2H, Ar-CH), 7.79 (dd, J = 1.6, 7.8 Hz, 1H, Ar-CH), 7.76 (d, J = 8.0 Hz, 2H, Ar-CH), 7.53 (td, J = 2.0, 7.8 Hz, 1H, Ar-CH), 7.14 (td, J = 0.8, 7.6 Hz, 1H, Ar-CH), 7.08 (dd, J = 0.8, 8.4 Hz, 1H, Ar-CH), 6.53 (d, J = 1.6 Hz, 1H, CH); ^{13}C NMR (100 MHz, DMSO-d_6): δ_C (ppm) 83.88, 112.75, 117.32, 118.76, 118.88, 123.04, 127.93, 128.72, 133.05, 135.16, 142.49, 156.95, 162.68.

2-(2-Chloro-5-nitrophenyl)-2H-benzo[e][1,3]oxazin-4(3H)-one (**3g**). mp: 197–198 °C; IR (KBr, cm^{-1}): ν 3334, 3079, 2919, 1690, 1612, 1525, 1469, 1387, 1255, 1149, 1057; ^{1}H NMR (400 MHz, DMSO-d_6): δ_H (ppm) 9.14 (s, 1H, NH), 8.48 (d, J = 2.4 Hz, 1H, Ar-CH), 8.34 (dd, J = 2.8, 8.8 Hz, 1H, Ar-CH), 7.89 (d, J = 8.8 Hz, 1H, Ar-CH), 7.85 (dd, J = 1.2, 7.8 Hz, 1H, Ar-CH), 7.56 (td, J = 1.6, 7.2 Hz, 1H, Ar-CH), 7.20 (t, J = 7.6 Hz, 1H, Ar-CH), 7.10 (d, J = 8.4 Hz, 1H, Ar-CH), 6.72 (s, 1H, CH); ^{13}C NMR (100 MHz, DMSO-d_6): δ_C (ppm) 81.66, 117.19, 118.56, 123.41, 124.19, 126.58, 128.06, 132.14, 135.30, 135.51, 139.95, 146.80, 156.92, 162.87. Analysis Calcd. for $C_{14}H_9ClN_2O_4$: C, 55.19; H, 2.98; N, 9.19. Found: C, 55.27; H, 2.80; N, 9.08.

2-(Naphthalen-1-yl)-2H-benzo[e][1,3]oxazin-4(3H)-one (**3h**). mp: 213–215 °C; IR (KBr, cm^{-1}): ν 3184, 3080, 2930, 1682, 1609, 1582, 1405, 1218, 1149, 1081; ^{1}H NMR (400 MHz, DMSO-d_6): δ_H (ppm) 9.14 (s, 1H, NH), 8.45–8.43 (m, 1H, Ar-CH), 8.05-8.01 (m, 2H, Ar-CH), 7.89 (dd, J = 1.6, 7.6 Hz, 1H, Ar-CH), 7.78 (d, J = 6.4 Hz, 1H, Ar-CH), 7.63–7.55 (m, 3H, Ar-CH), 7.52 (td, J = 2.0, 7.8 Hz, 1H, Ar-CH), 7.17 (td, J = 1.2, 7.6 Hz, 1H, Ar-CH), 7.03 (d, J = 1.2 Hz, 1H, Ar-CH), 7.00 (d, J = 0.8 Hz, 1H, CH); ^{13}C NMR (100 MHz, DMSO-d_6): δ_C (ppm) 84.40, 117.17, 119.03, 122.81, 124.97, 125.54, 126.55, 126.95, 127.02, 128.04, 129.10, 130.81, 130.84, 132.09, 134.04, 134.91, 157.58, 163.28. Analysis Calcd. for $C_{18}H_{13}NO_2$: C, 78.53; H, 4.76; N, 5.09. Found: C, 78.41; H, 4.62; N, 5.17.

Spiro[benzo[e][1,3]oxazine-2,1'-cyclohexan]-4(3H)-one (**3i**). mp: 180–182 °C; ^{1}H NMR (400 MHz, DMSO-d_6): δ_H (ppm) 8.63 (s, 1H, NH), 7.73 (dd, J = 1.6, 7.6 Hz, 1H, Ar-CH), 7.49 (td, J = 1.6, 8.0 Hz, 1H, Ar-CH), 7.07 (td, J = 0.8, 6.8 Hz, 1H, Ar-CH), 6.99 (dd, J = 0.8, 8.0 Hz, 1H, Ar-CH), 1.99–1.96 (m, 2H, CH_2), 1.63–1.23 (m, 8H, $4CH_2$); ^{13}C NMR (100 MHz, DMSO-d_6): δ_C (ppm) 21.88, 24.62, 35.85, 88.02, 117.38, 118.35, 122.14, 127.47, 134.81, 141.18, 161.45.

N,*N*'-methylenebis(2-hydroxybenzamide) (**3j**). mp: 299–300 °C; IR (KBr, cm^{-1}): ν 3396, 3896, 1639, 1594, 1491, 1330, 1225, 1112; ^{1}H NMR (400MHz, DMSO-d_6): δ_H (ppm) 12.22 (broad, 2H, 2OH), 9.47 (s, 2H, 2NH), 7.91 (dd, J = 1.6, 8.0 Hz, 2H, Ar-CH), 7.39 (t, J = 8.0 Hz, 2H, Ar-CH), 6.92–6.87 (m, 4H, Ar-CH), 4.90 (t, J = 5.2 Hz, 2H, CH_2); ^{13}C NMR (100 MHz, DMSO-d_6): δ_C