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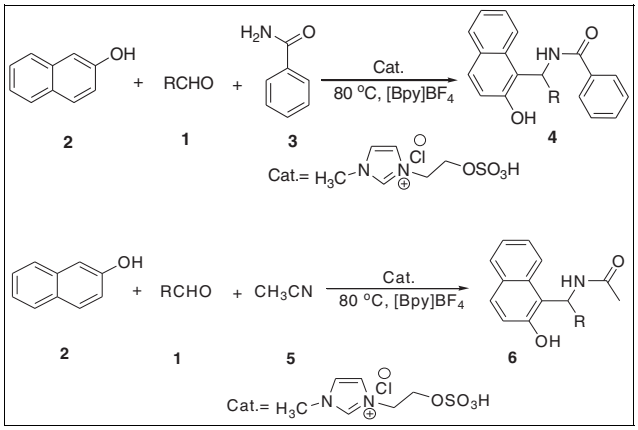

The efficient one-pot syntheses of Betti bases by the three-component reaction of aromatic aldehyde, 2-naphthalen, and acetonitrile (or benzamide) catalyzed by 1-methyl-3-(2-(sulfooxy)ethyl)-1*H*-imidazol-3-ium chloride is reported. The solvent can be recycled easily.

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INTRODUCTION

The Betti bases (BT) chemistry has started at the beginning of the 20th century when Betti reported the synthesis of 1-(a-aminobenzyl)-2-naphthol [1]. The preparation of substituted Betti base derivatives by the modified Mannich reaction has subsequently become of considerable importance because a C–C bond is formed under mild experimental conditions [2]. In the past decade, interest in the Betti bases has turned to their application in chiral chemistry. The Betti bases and their *N*-substituted derivatives can serve as chiral catalysts [3–12], and the nonracemic Betti bases can be applied successfully as a new chiral auxiliary [13]. Chiral betti bases derivatives can also provide convenient access to many useful synthetic building blocks to afford a wide variety of chiral compounds [14].

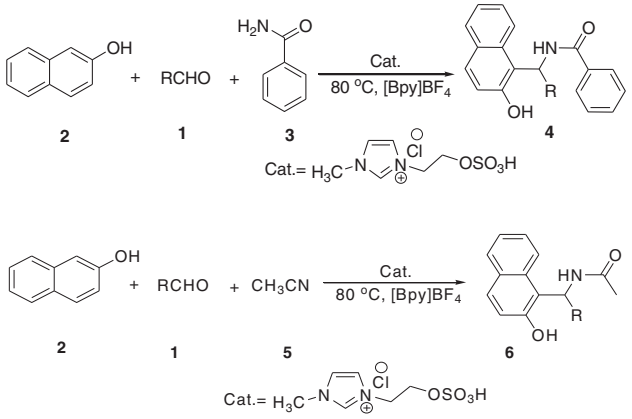
The base of obtaining chiral BT is the efficient synthesis of their racemic derivatives. The synthesis of racemic Betti bases has been generally promoted by acids, such as Fe $(HSO_4)_3$ [15], $Ce(SO_4)_2$ [16], CF_3COOH [17], I_2 [18,19], $FeCl_3$–SiO_2 [20], $HClO_4$–SiO_2 [21], $NaHSO_4$ [22], and $ClSO_3H$ [23,24]. However, some shortcomings such as using violent toxic organic solvents and expensive, low-selective catalysts, rigorous condition, high reaction temperature, and long reaction times limited the scope of appropriate substrates. Therefore, introduction of clean procedures and utilizing ecofriendly green catalyst can be simply recycled at the end of reaction have attracted more attention.

1-Methyl-3-(2-(sulfooxy)ethyl)-1*H*-imidazol-3-ium chloride (MSI) has been synthesized in our lab and proven as a very useful reagent in the preparation of some organic compounds, such as 14-aryl or alkyl-14*H*-dibenzo[*a,j*]xanthenes [25]. To research its new application, herein we described an MSI-catalyzed facile synthesis of Betti bases via a three-component reaction of aromatic aldehyde, 2-naphthalen, and acetonitrile (or benzamide) (Scheme 1).

RESULTS AND DISCUSSION

To optimize the reaction condition, the three-component reaction of *p*-nitrobenzaldehyde (**1h**), 2-naphthalen (**2**), and benzamide (**3**) was employed as a model reaction. The effects of catalysts were evaluated initially (Table 1). It was found that MSI was the most efficient catalyst (Table 1, Entries 1–7). The important role of MSI may be attributed to its fitting acidity, stability, and nonvolatility. Subsequently, the effects of solvents and reaction temperature were also evaluated. It was shown that when common organic solvents and water were used as solvent, the yields were very low (Table 1, Entries 8–12). It may be because

Scheme 1. One-pot synthesis of Betti bases catalyzed by MSI.



in these organic solvents, this reaction could only give some cross aldol condensation products. And these low-boiling organic solvents cannot offer enough energy to afford desired product that may be a thermodynamic-controlled one. Meanwhile, water may be making the equilibrium toward reactants. However, when three kinds of ionic liquids were used as reaction medium, the yield of **4h** increased to 83–95% surprisedly (Table 1, Entries 7, 13, and 14). [Bpy]BF_4 gave the highest yield because of its strongest basicity among these ionic liquids. Finally, when the temperature was increased to 80°C with [Bpy]BF_4 as the solvent, the reaction proceeded smoothly (Table 1, Entries 7 and 20–23). However, the increase in temperature did not enhance the yield of the product.

To explore the application of this method, the scope of the substrates was evaluated with a variety of aromatic or aliphatic aldehydes (Tables 2, 3). Obviously, the protocol was effective with aromatic aldehydes having either electron-withdrawing or electron-donating groups and also with aliphatic aldehydes. The electronic and steric effect of substituents in aromatic aldehydes had no significant effect on the yields. Also, we have investigated the reusability of [Bpy]BF_4 and observed that the ionic liquid was successfully reused for four cycles without significant loss of activity (Table 2, Entry 1).

Although the mechanism of this reaction remains to be fully clarified, the formation of compounds **4** and **6** could be explained by the sequence in Scheme 2. We supposed that the reaction may proceed via **A**, which was formed by the nucleophilic addition of 2-naphthol to aldehyde catalyzed by MSI. Subsequent Michael addition of **A** with the amide afforded the expected amidoalkyl naphthol (**4**). We discovered that when undehydrate acetonitrile was used as reagent, compound **6** can be obtained successfully. But when anhydrous acetonitrile was used, we can only obtain compound **7**. It is clear that in this process,

Table 1

Optimization of reaction conditions.

Entry	Catalyst	*X* (mol%)	Solvent	*t* (°C)	Yield (%)
1	I_2	3	[Bpy]BF_4	80	21
2	SSA	3	[Bpy]BF_4	80	54
3	TsOH	3	[Bpy]BF_4	80	80
4	HCl	3	[Bpy]BF_4	80	11
5	SiO_2	3	[Bpy]BF_4	80	<5
6	HOAc	3	[Bpy]BF_4	80	19
7	MSI	3	[Bpy]BF_4	80	95
8	MSI	3	C_2H_5OH	80	51
9	MSI	3	THF	80	<5
10	MSI	3	DMF	80	43
11	MSI	3	H_2O	80	<5
12	MSI	3	Ethyl acetate	80	<5
13	MSI	3	[Bmim]BF_4	80	83
14	MSI	3	[Bpy]Br	80	80
15	MSI	1	[Bpy]BF_4	80	58
16	MSI	2	[Bpy]BF_4	80	76
17	MSI	4	[Bpy]BF_4	80	95
18	MSI	5	[Bpy]BF_4	80	94
19	MSI	6	[Bpy]BF_4	80	92
20	MSI	3	[Bpy]BF_4	60	67
21	MSI	3	[Bpy]BF_4	70	80
22	MSI	3	[Bpy]BF_4	90	93
23	MSI	3	[Bpy]BF_4	100	91

SSA, silica sulfuric acid; MSI, 1-methyl-3-(2-(sulfooxy)ethyl)-1*H*-imidazol-3-ium chloride.
All reactions were carried out in the scale of 2.0 mmol of *p*-nitrobenzaldehyde (**1h**), 2.0 mmol of 2-naphthalen (**2**), and 2.0 mmol of benzamide (**3**) in 25 min.

Table 2

Synthesis of **4** under optimum condition.

Entry	*R*	Time (min)	Yield (%)	mp (°C) Found	mp (°C) Reported
4a	C_6H_5	50	90 (90, 90, 89, 88)[a]	238–239	238–239 [27]
4b	3,4,5-$(OCH_3)_3C_6H_2$	60	85	229–230	235–238 [29]
4c	4-$OCH_3C_6H_4$	60	89	211–212	208–209 [27]
4d	2,3-$(CH_3)_2C_6H_3$	30	87	223–224	–
4e	4-FC_6H_4	50	90	233–234	233–234 [30]
4f	4-ClC_6H_4	50	82	240–241	182–183 [29]
4g	2-OHC_6H_4	40	84	250–251	–
4h	4- $NO_2C_6H_4$	25	92	249–250	248–250 [28]
4i	2,3-$(OCH_3)_2C_6H_3$	35	90	225–226	–
4j	3-NO_2 C_6H_4	25	95	217–218	255–257 [29]
4k	2,4-ClC_6H_3	40	86	235–236	263–264 [31]
4l	2-$OCH_3C_6H_4$	40	82	220–221	266–267 [28]
4m	2-ClC_6H_4	50	83	248–249	284–285 [31]
4n	2-BrC_6H_4	50	85	239–240	228–230 [31]
4o	3-BrC_6H_4	50	89	225–226	–
4p	3-FC_6H_4	50	87	217–218	–
4q	3-ClC_6H_4	50	83	236–237	–
4r	4-$CHOC_6H_4$	60	91	257–258	–
4s	CH_3CH_2	35	94	206–207	–

All reactions were carried out on a 2.0 mmol of aromatic aldehyde, 2.0 mmol of 2-naphthalen, and 2.0 mmol of benzamide.
[a]Yields after recovery of $[Bpy]BF_4$.

Table 3

Synthesis of **6** under optimum condition.

Entry	*R*	Time (h)	Yield (%)	mp (°C) Found	mp (°C) Reported
6a	C_6H_5	12	80	245–246	218–220 [28]
6b	4-CNC_6H_4	10	86	251–252	232–234 [35]
6c	4-$OCH_3C_6H_4$	12	81	183–184	183–184 [27]
6d	4-$CH_3C_6H_4$	10	83	223–224	223–224 [27]
6e	4-FC_6H_4	12	85	233–234	233–234 [31]
6f	4-ClC_6H_4	12	84	223–224	230–231 [32]
6g	4-OHC_6H_4	12	80	212–213	206–208 [37]
6h	4-IC_6H_4	12	87	240–241	–
6i	2,3-$(OCH_3)_2C_6H_3$	12	82	236–237	235–236 [29]
6j	3-NO_2 C_6H_4	10	88	241–242	256–257 [27]
6k	2,4-ClC_6H_3	12	82	201–202	201–203 [34]
6l	2-$OCH_3C_6H_4$	12	81	208–209	241–242 [36]
6m	2-ClC_6H_4	12	81	213–215	213–215 [32]
6n	2-BrC_6H_4	12	83	220–221	228–230 [37]
6o	3-BrC_6H_4	12	80	238–239	250–252 [37]
6p	3-FC_6H_4	12	85	248–249	248–249 [34]
6q	4-BrC_6H_4	12	83	227–229	228–230 [33]
6r	4-NO_2 C_6H_4	10	89	249–250	248–250 [34]

All reactions were carried out on a 2.0 mmol of aromatic aldehyde, 2.0 mmol of 2-naphthalen, and 2.0 mmol of acetonitrile.

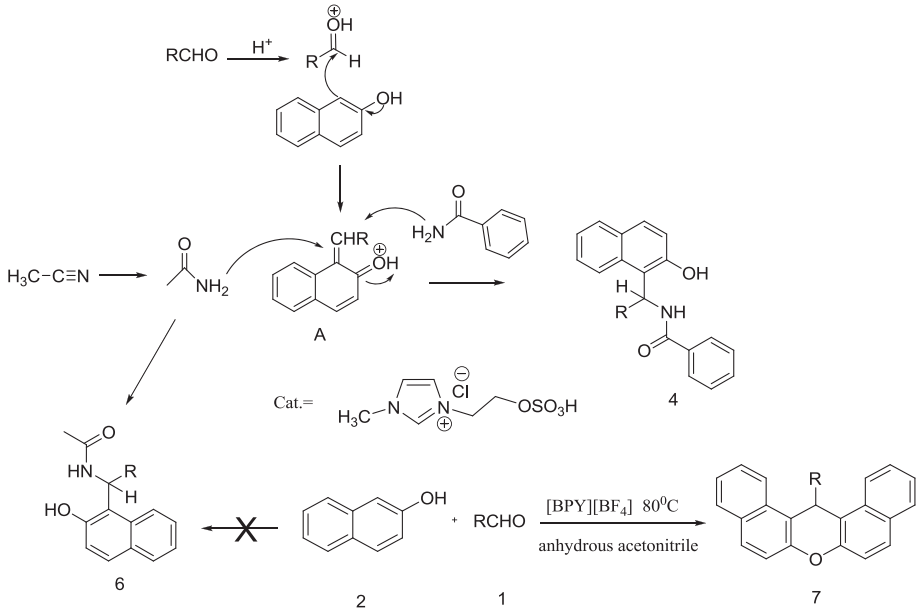
acetonitrile undergoes hydrolysis to give acetamide, which further reacted with **A** to give **6**.

In summary, we have described the synthesis of Betti bases via the one-pot three-component reaction of aldehyde, 2-naphthalen, and acetonitrile (or benzamide) catalyzed by MSI. This new simple method paves the way for the synthsis of chrial Betti bases.

EXPERIMENTAL

General information. Commercial solvents and reagents were used as received. Melting points were uncorrected. IR spectra were recorded on Varian F-1000 spectrometer in KBr with absorptions in cm^{-1}. ^1H NMR was determined on Varian-400 MHz spectrometer in DMSO-d_6. (*J* values are in Hz). Chemical shifts were expressed in parts per million downfield from

Scheme 2. Proposed mechanism for the synthesis of 1-methyl-3-(2-(sulfooxy)ethyl)-1*H*-imidazol-3-ium chloride.



internal standard TMS. The synthesis of MSI was followed by the literatured method [26].

The procedure for the synthesis of 4. A mixture of aldehyde (2 mmol), 2-naphthalen (2 mmol), benzamide (2 mmol), ionic liquid [Bpy]BF_4 (2 mL), and MSI (0.06 mmol) was stirred at 80°C for 25–60 min (monitored by TLC). The resulting solid was washed with water and dried in vacuum. The crude product was purified by recrystallization from ethanol and DMF to give **4**.

The procedure for the synthesis of 6. A mixture of aldehyde (2 mmol), 2-naphthalen (2 mmol), acetonitrile (2 mmol), ionic liquid [Bpy]BF_4 (2 mL), and MSI (0.06 mmol) was stirred at 80°C for 10–12 h (monitored by TLC). The resulting solid was washed with water and dried in vacuum. The crude product was purified by recrystallization from ethanol and DMF give to **6**.

The spectral data of new products are the following.

N-((2-hydroxynaphthalen-1-yl)(2,3-dimethylphenyl)methyl) benzamide (4d). mp 223–224°C, white solid; IR (KBr, *v*, cm^{-1}): 3423, 3158, 3027, 1630, 1573, 1539, 1488, 1344, 1271, 1075, 942, 819, 754; ^{1}H NMR (400 MHz, DMSO-d_6) δ 10.04 (s, 1H), 8.94 (d, *J* = 8.0 Hz, 1H), 8.00 (d, *J* = 8.8 Hz, 1H), 7.86 (d, *J* = 7.2 Hz, 2H), 7.75–7.81 (m, 2H), 7.50 (t, *J* = 7.2 Hz, 1H), 7.36–7.44 (m, 3H), 7.32 (d, *J* = 7.2 Hz, 1H), 7.20–7.28 (m, 2H), 7.07 (d, *J* = 8.0 Hz, 1H), 6.90–6.96 (m, 2H), 2.26 (d, *J* = 4.8 Hz, 6H); HRMS (ESI) *m/z*: calcd for $[M + Na]^+$ $C_{26}H_{23}NO_2$: 404.1770; found: 404.1774.

N-((2-hydroxynaphthalen-1-yl)(2-hydroxyphenyl)methyl) benzamide (4g). mp 250–251°C, white solid; IR (KBr, *v*, cm^{-1}): 3426, 3140, 3065, 1634, 1573, 1540, 1488, 1272, 1056, 823, 753, 711; ^{1}H NMR (400 MHz, DMSO-d_6) δ 9.99 (s, 1H), 9.01 (d, *J* = 7.6 Hz, 1H), 8.07 (d, *J* = 8.8 Hz, 1H), 7.88 (d, *J* = 7.6 Hz, 2H), 7.76–7.82 (m, 2H), 7.51 (t, *J* = 7.2 Hz, 1H), 7.41–7.49 (m, 6H), 7.34 (d, *J* = 7.6 Hz, 1H), 7.24–7.29 (m, 3H), 7.17 (d, *J* = 8.8 Hz, 1H); HRMS (ESI) *m/z*: calcd for $[M + Na]^+$ $C_{24}H_{19}NO_3$: 393.3100; found: 393.3104.

N-((2-hydroxynaphthalen-1-yl)(2,3-dimethoxyphenyl)methyl) benzamide (4i). mp 225–226°C, white solid; IR (KBr, *v*, cm^{-1}): 3424, 3129, 3058, 1633, 1573, 1537, 1479, 1263, 1065, 1001, 820, 755, 709; ^{1}H NMR (400 MHz, DMSO-d_6) δ 10.20 (s, 1H), 8.94 (d, *J* = 8.8 Hz, 1H), 8.20 (d, *J* = 8.8 Hz, 1H), 7.85 (d, *J* = 8.4 Hz, 2H), 7.73–7.80 (m, 2H), 7.43–7.52 (m, 5H), 7.28 (t, *J* = 7.9 Hz, 1H), 7.19 (d, *J* = 8.8 Hz, 1H), 7.10 (d, *J* = 6.8 Hz, 1H), 6.91–6.98 (m, 2H), 3.77 (s, 3H), 3.55 (s, 3H); HRMS (ESI) *m/z*: calcd for $[M + Na]^+$ $C_{26}H_{23}NO_4$: 436.1696; found: 436.1696.

N-((3-bromophenyl)(2-hydroxynaphthalen-1-yl)methyl) benzamide (4o). mp 225–226°C, white solid; IR (KBr, *v*, cm^{-1}): 3394, 3197, 3065, 1627, 1576, 1508, 1474, 1269, 1053, 805, 823, 692, 634; ^{1}H NMR (400 MHz, DMSO-d_6) δ 10.38 (s, 1H), 9.05 (d, *J* = 8.0 Hz, 1H), 8.08 (d, *J* = 8.8 Hz, 1H), 7.81–7.88 (m, 4H), 7.56 (t, *J* = 7.6 Hz, 1H), 7.48 (t, *J* = 8.0 Hz, 3H), 7.41–7.44 (m, 2H), 7.29–7.34 (m, 2H), 7.23–7.26 (m, 3H); HRMS (ESI) *m/z*: calcd for $[M + Na]^+$ $C_{24}H_{18}BrNO_2$: 454.0560; found: 454.0585.

N-((3-fluorophenyl)(2-hydroxynaphthalen-1-yl)methyl) benzamide (4p). mp 217–218°C, white solid; IR (KBr, *v*, cm^{-1}): 3414, 3177, 3071, 1627, 1573, 1538, 1480, 1261, 1127, 936, 815, 740, 689; ^{1}H NMR (400 MHz, DMSO-d_6) δ 10.37 (s, 1H), 9.04 (d, *J* = 8.0 Hz, 1H), 8.09 (d, *J* = 8.8 Hz, 1H), 7.81–7.89 (m, 4H), 7.56 (t, *J* = 7.6 Hz, 1H), 7.49 (t, *J* = 7.6 Hz, 3H), 7.29–7.35 (m, 3H), 7.25 (d, *J* = 8.8 Hz, 1H), 7.02–7.11 (m, 3H); HRMS (ESI) *m/z*: calcd for $[M + Na]^+$ $C_{24}H_{18}FNO_2$: 394.1398; found: 394.1381.

N-((3-chlorophenyl)(2-hydroxynaphthalen-1-yl)methyl) benzamide (4q). mp 236–237°C, white solid; IR (KBr, *v*, cm^{-1}): 3397, 3198, 3067, 1627, 1576, 1508, 1475, 1270, 1166, 1054, 806, 729, 681; ^{1}H NMR (400 MHz, DMSO-d_6) δ 10.37 (s, 1H), 9.04 (d, *J* = 8.4 Hz, 1H), 8.08 (d, *J* = 8.4 Hz, 1H), 7.81–7.88 (m, 4H), 7.56 (t, *J* = 7.6 Hz, 1H), 7.46–7.51 (m, 3H), 7.29–7.34 (m, 5H), 7.22–7.27 (m, 2H); HRMS (ESI) *m/z*: calcd for $[M + Na]^+$ $C_{24}H_{18}ClNO_2$: 410.1081; found: 410.1089.

N-((4-formylphenyl)(2-hydroxynaphthalen-1-yl)methyl) benzamide (4r). mp 257–258°C, white solid; IR (KBr, *v*, cm^{-1}): 3419, 3196, 3071, 1633, 1576, 1516, 1436, 1268, 1054, 809, 732, 623; ^1H NMR (400 MHz, DMSO-d_6) δ 10.37 (s, 1H), 9.00 (d, $J = 4.4$ Hz, 1H), 8.07 (d, $J = 8.0$ Hz, 1H), 7.76–7.82 (m, 5H), 7.53 (t, $J = 7.2$ Hz, 1H), 7.44 (t, $J = 8.0$ Hz, 4H), 7.29 (d, $J = 7.6$ Hz, 1H), 7.19–7.24 (m, 5H); HRMS (ESI) *m/z*: calcd for $[M + Na]^+$ $C_{25}H_{19}NO_3$: 404.1771; found: 404.1766.

N-(1-(2-hydroxynaphthalen-1-yl)propyl)benzamide (4s). mp 206–207°C, white solid; IR (KBr, *v*, cm^{-1}): 3405, 3178, 3068, 1635, 1574, 1514, 1436, 1348, 1174, 1073, 816, 748, 707; ^1H NMR (400 MHz, DMSO-d_6) δ 10.09 (s, 1H), 8.61 (d, $J = 8.4$ Hz, 1H), 8.22 (d, $J = 8.8$ Hz, 1H), 7.78–7.81 (m, 3H), 7.70 (d, $J = 8.8$ Hz, 1H), 7.44–7.52 (m, 5H), 7.29 (t, $J = 7.6$ Hz, 1H), 7.18 (d, $J = 8.8$ Hz, 1H), 2.11–2.17 (m, 1H), 1.92–2.02 (m, 1H), 0.92 (t, $J = 7.6$ Hz, 3H); HRMS (ESI) *m/z*: calcd for $[M + Na]^+$ $C_{20}H_{19}NO_2$: 328.1477; found: 328.1478.

N-((4-cyanophenyl)(2-hydroxynaphthalen-1-yl)methyl) acetamide (6b). mp 251–252°C, white solid; IR (KBr, *v*, cm^{-1}): 3379, 3108, 2958, 2231, 1636, 1576, 1509, 1438, 1280, 1063, 819, 752, 594; ^1H NMR (400 MHz, DMSO-d_6) δ 10.20 (s, 1H), 8.56 (d, $J = 8.0$ Hz, 1H), 7.80–7.84 (m, 3H), 7.73 (d, $J = 8.0$ Hz, 2H), 7.40 (t, $J = 6.4$ Hz, 1H), 7.27–7.34 (m, 3H), 7.22 (d, $J = 9.2$ Hz, 1H), 7.15 (d, $J = 8.0$ Hz, 1H), 2.01 (s, 3H); IR (KBr, *v*, cm^{-1}): 3379, 3108, 2958, 2231, 1636, 1576, 1509, 1438, 1280, 1063, 819, 752, 594; HRMS (ESI) *m/z*: calcd for $[M + H]^+$ $C_{20}H_{16}N_2O_2$: 318.3080; found: 318.3096.

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REFERENCES AND NOTES

[1] Betti, M. Org Synth Colloid 1941, 1, 381.
[2] Szatmari, I. Fueloep, F. Curr Org Synth 2004, 1, 155.
[3] Cardellichio, C.; Ciccarella, G.; Naso, F.; Schingaro, E.; Scordari, F. Tetrahedron: Asymmetry 1998, 9, 3667.
[4] Cardellichio, C.; Ciccarella, G.; Naso, F.; Perna, F.; Tortorella, P. Tetrahedron 1999, 55, 14685.
[5] Cimarelli, C.; Mazzanti, A.; Palmieri, G.; Volpini, E. J Org Chem 2001, 66, 4759.
[6] Liu, D. X.; Zhang, L. C.; Wang, Q.; Da, C. S.; Zin, Z. Q.; Wang, R.; Choi, M. K. C.; Chan, A. S. C. Org Lett 2001, 3, 2733.
[7] Cimarelli, C.; Palmieri, G.; Volpini, E. Tetrahedron: Asymmetry 2002, 13, 2417.
[8] Lu, J.; Xu, X.; Wang, S.; Wang, C.; Hu, Y.; Hu, H. J Chem Soc Perkin Trans 2002, 1, 2900.
[9] Lu, J.; Xu, X.; Wang, S.; Wang, C.; He, J.; Hu, Y.; Hu, H. Tetrahedron Lett 2002, 43, 8367.
[10] Ji, J. X.; Qui, L. Q.; Yi, C. W. J Org Chem 2003, 68, 1589.
[11] Ji, J. X.; Wu, J.; Au-Yeung, T. T. L.; Yip, C. W.; Haynes, R. K.; Chan, A. S. C. J Org Chem 2005, 70, 1093.
[12] Dong, Y.; Li, R.; Lu, J.; Xu, X.; Wang, X.; Hu, Y. J Org Chem 2005, 70, 8617.
[13] Wang, X.; Dong, Y.; Sun, J.; Xu, X.; Li, R.; Hu, Y. J Org Chem 2005, 70, 1897.
[14] Heydenreich, M.; Koch, A.; Klod, S.; Szatmari, I.; Fulop, F.; Kleinpeter, E. Tetrahedron 2006, 62, 11081.
[15] Hamid, S. R.; Yarahmadi, H.; Ghashang, M. Med Chem Lett 2008, 18(2), 788.
[16] Nagarajan, S. P.; Perumal, P. T. Tetrahedron Lett 2006, 47 (42), 7481.
[17] Das, B.; Laxminarayana, K.; Thirupathi, P.; Ramarao, B. Synlett 2007, 20, 3103.
[18] Nagarajan, S. P.; Perumal, P. T. Tetrahedron 2008, 64(13), 2972.
[19] Das, B.; Keetha, L.; Ravikanth, B.; Rama, R. B. J Mol Catal A: Chem 2007, 261(2), 180.
[20] Hamid, S. R.; Yarahmadi, H. Tetrahedron Lett 2008, 49(8), 1297.
[21] Hamid, S. R.; Yarahmadi, H.; Ghashang, M. Tetrahedron 2008, 64(7), 1263.
[22] Hamid, S. R.; Yarahmadi, H. ARKIVOC (Gainesville, FL, United States) 2008, 2, 105.
[23] Anary, A. M.; Hassanabadi, A.; Kamali, G. M.; Saidipoor, A.; Anaraki, A. H. J Chem Res 2007, 11, 644.
[24] Anary, A. M.; Hassanabadi, A.; Ghanee, F.; Tahmasbnia, N. J Chem Res 2008, 2, 107.
[25] Wu, H.; Chen, X. M.; Wan, Y.; Xin, H. Q.; Xu, H. H.; Yue, C. H.; Pang, L. L.; Ma, R. Synthetic Comm 2009, 39, 3762.
[26] Wan, Y.; Chen, X. M.; Pang, L. L.; Ma, R.; Yue, C. H.; Yuan, R.; Lin, W.; Yin, W.; Bo, R. C.; Wu, H. Synthetic Comm 2010, 40, 2320.
[27] Nandi, G. C.; Sama, S.; Kumar, R.; Singh, M. S. Tetrahedron Lett 2009, 50, 7220.
[28] Hajipour, A. R.; Ghayeb, Y.; Sheikhan, N.; Ruoho, A. E. Tetrahedron Lett 2009, 50, 5649.
[29] Kantevari, S.; Srinivasu, V. N.; Vuppalapati, L. N. Catal Commun 2007, 8, 1857.
[30] Patil, S. B.; Singh, P. R.; Samant, S. D. Synthetic Comm 2007, 37(10), 1659.
[31] Shaterian, H. R.; Hosseinian, A.; Yarahmadi, H.; Ghashang, M. Lett Org Chem 2008, 5(4), 290.
[32] Mahdavinia, G. H.; Bigdeli, M. A.; Heravi, M. M. Chin Chem Lett 2008, 19, 1171.
[33] Kantevari, S.; Vuppalapati, S. V. N.; Nagarapu, L. Catal Commun 2007, 8, 1857.
[34] Shaterian, H. R.; Yarahmadi, H. Tetrahedron Lett 2008, 49, 1297.
[35] Abdol, R.; Hajipour, A. B.; Yosof, G. B.; Nafisehsadat, S. B.; Amold, E.; Ruoho, A. Tetrahedron Lett 2009, 50, 5649.
[36] Ganesh, C. N.; Subhasis, S.; Ram, K.; Singh, M. S. Tetrahedron Lett 2009, 50, 7220.
[37] Zhang, P.; Zhang, Z. H. Monatsh Chem 2009, 140, 199.