available at www.sciencedirect.com

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

Article

One-pot synthesis of 1-amidoalkyl-2-naphthols catalyzed by melamine-Br₃ under solvent-free conditions

Arash Ghorbani-Choghamarani*, Shima Rashidimoghadam

Department of Chemistry, Faculty of Science, Ilam University, Ilam, Iran

ARTICLE INFO

Article history:

Received 17 December 2013

Accepted 9 January 2014

Published 20 July 2014

Keywords:

Multi-component reaction

Amidoalkyl naphthol

Tribromo-melamine

Solvent-free

One-pot

ABSTRACT

A facile and efficient method has been developed for the synthesis of 1-amidoalkyl-2-naphthols via the one-pot multi-component condensation of 2-naphthol with aromatic aldehydes and acetamide or thioacetamide in the presence of melamine-Br₃ under solvent-free conditions. There are several advantages to this reaction, including high yields, short reaction time, and high catalytic efficiency.

© 2014, Dalian Institute of Chemical Physics, Chinese Academy of Sciences.

Published by Elsevier B.V. All rights reserved.

1. Introduction

Multi-component reactions (MCRs), where three or more reactants are combined into a one-pot process, represent an increasingly important and attractive area of research in organic synthesis because they provide high levels of efficiency via the combination of several operational steps, as well as allowing for operational steps involving the isolation of intermediates or changing of reaction conditions to be avoided. In terms of the advantages that they offer, MCRs are general efficient procedures that provide high levels of atom economy and significant cost savings. The discovery and development of novel and known MCRs have consequently become a popular area of research in organic chemistry.

Compounds containing 1,3-amino-oxygenated functional groups are frequently used as biologically active natural products, and this structural motif can also be found in a number of potent drugs such as nucleoside antibiotics and the HIV prote-

ase inhibitors [1,2], such as ritonavir and liponavir [3,4]. 1-Amidoalkyl-2-naphthol derivatives can be converted to 1-aminomethyl-2-naphthols via an amide hydrolysis reaction. These compounds are important synthetic building blocks and exhibit a range of biological activity, including depressive and bradycardia effects in humans [4,5].

1-Amidoalkyl-2-naphthols can be prepared by the multi-component condensation of aryl aldehydes with 2-naphthol and acetamide or thioacetamide in the presence of an appropriate catalyst such as RuCl₂(PPh₃)₃ [6], sulfamic acid [7,8], Ce(SO₄)₂ [9], [FemSILP]-L-proline [10], Bi(NO₃)₃·5H₂O [11], K₅CoW₁₂O₄₀·3H₂O [12], Hf(NP₂)₄ [13], H₃PW₁₂O₄₀ [14], Yb(OTf)₃ [15], Fe(HSO₄)₃ [16], montmorillonite K10 clay [17], p-TSA [18], H₄SiW₁₂O₄₀ [19], zeolite [20], 2,4,6-trichloro-1,3,5-triazine [21], iodine [22], PFPAT [23], and poly(4-vinylpyridinium butane sulfonic acid) hydrogen sulfate [24].

In most cases, however, the application of these methods is limited by their requirement for prolonged reaction time, ul-

* Corresponding author. Tel/Fax: +98-841 2227022; E-mail: arashghch58@yahoo.com, aghorbani@mail.ilam.ac.ir

This work was supported by Research Facilities of Ilam University, Ilam, Iran.

DOI: 10.1016/S1872-2067(14)60029-2 | http://www.sciencedirect.com/science/journal/18722067 | Chin. J. Catal., Vol. 35, No. 7, July 2014

trasonic or microwave irradiation, and the use of stoichiometric quantities of toxic and corrosive catalysts. Furthermore, the existing procedures generally provide low yields of the desired products. Therefore, the discovery of a new, inexpensive, and readily available catalyst with high catalytic activity and short reaction time for the preparation of amidoalkyl naphthols is strongly desired. Tribromo-melamine (melamine-Br₃) is a homogeneous and non-hygroscopic solid catalyst that can be readily prepared by reaction of melamine with Br under alkali conditions (Scheme 1) [25].

Melamine-Br₃ is stable under a variety of different reaction conditions, including acidic and basic conditions. It is noteworthy that melamine-Br₃ is produced via a facile and clean process that does not require a complicated work-up procedure. Melamine-Br₃ has been used in a variety of different reactions, including the synthesis of 2-aryl thiazolines [25] and the trimethyl silylation of hydroxyl groups with 1,1,1,3,3,3-hexamethyldisilazane (HMDS) [26]. Herein, we report a melamine-Br₃-catalyzed one-pot MCR for the synthesis of biologically interesting 1-amidoalkyl-2-naphthols.

2. Experimental

2.1. General procedure for the synthesis of 1-amidoalkyl-2-naphthols

All of the chemicals used here were purchased from Fluka, Merck, and Aldrich chemical companies. The products were characterized by comparison of their spectral (¹H and ¹³C NMR) and physical data with those of authentic samples.

Melamine-Br₃ (0.054 g, 0.15 mmol) was added to a mixture of aldehyde (1 mmol), 2-naphthol (1 mmol) and acetamide or thioacetamide (1.5 mmol), and the resulting mixture was stirred at 130 °C in an oil bath for the appropriate time. Upon completion of the reaction, as determined by TLC, the mixture was cooled to room temperature, and purified directly by column chromatography over silica gel using a mixture of acetone/*n*-hexane (3:7, v/v) as the eluent to give the desired product.

2.2. Condensation of 2-naphthol with terephthalaldehyde and acetamide to bis-1-amidoalkyl-2-naphthol

A mixture of terephthalaldehyde (0.134 g, 1 mmol), 2-naphthol (0.36 g, 2.5 mmol), acetamide (0.22 g, 3.75 mmol), and melamine-Br₃ (0.054 g, 0.15 mmol) was stirred at 130 °C for the appropriate time. Upon completion of the reaction, as determined by TLC, the mixture was cooled to room temperature and purified directly by column chromatography over silica gel using a mixture of acetone/*n*-hexane (1:1, v/v) as the eluent to give the de-

sired product as a X solid.

2.3. Spectral data for products

N-[(2-Hydroxynaphthalen-1-yl)-(phenyl)methyl]acetamide (**a**). ¹H NMR (400 MHz, DMSO-*d*₆): δ = 1.98 (s, 3H), 7.12–7.38 (m, 6H), 7.76–7.84 (m, 3H), 8.45 (d, *J* = 8, 1H), 10.0 (s, 1H).

N-[(4-Chloro-phenyl)-(2-hydroxynaphthalen-1-yl)methyl]acetamide (**b**). ¹H NMR (400 MHz, DMSO-*d*₆): δ = 2.0 (s, 3H), 7.10 (d, *J* = 8.0 Hz, 1H), 7.17 (d, *J* = 8.4 Hz, 2H), 7.23 (d, *J* = 8.8 Hz, 1H), 7.26–7.33 (m, 3H), 7.39 (m, 1H), 7.78–7.83 (m, 3H), 8.48 (d, *J* = 8.0 Hz, 1H), 10.06 (s, 1H).

N-[(4-Bromo-phenyl)-(2-hydroxynaphthalen-1-yl)methyl]acetamide (**c**). ¹H NMR (400 MHz, DMSO-*d*₆): δ = 2.0 (s, 3H), 7.10 (m, 3H), 7.23–7.30 (m, 2H), 7.38 (d, *J* = 8.0 Hz, 1H), 7.45 (d, *J* = 8.4 Hz, 2H), 7.80 (m, 3H), 8.49 (d, *J* = 8.0 Hz, 1H), 10.07 (s, 1H); ¹H NMR (400 MHz, DMSO-*d*₆ + D₂O): δ = 1.98 (s, 3H), 7.07 (m, 3H), 7.20 (d, *J* = 8.8, 1H), 7.26 (m, 1H), 7.38 (m, 3H), 7.77 (m, 3H).

N-[(4-Fluoro-phenyl)-(2-hydroxynaphthalen-1-yl)methyl]acetamide (**d**). ¹H NMR (400 MHz, DMSO-*d*₆): δ = 2.0 (s, 3H), 7.06–7.12 (m, 3H), 7.17–7.3 (m, 4H), 7.39 (m, 1H), 7.77–7.83 (m, 3H), 8.49 (d, *J* = 8.4, 1H), 10.05 (s, 1H).

N-[(2-Hydroxynaphthalen-1-yl)-(2-nitrophenyl)methyl]acetamide (**e**). ¹H NMR (400 MHz, DMSO-*d*₆): δ = 9.75 (s, 1H), 8.60 (d, *J* = 8 Hz, 1H), 7.66–7.87 (m, 4H), 7.02–7.48 (m, 6H), 1.95 (s, 3H); ¹³C NMR (100 MHz, DMSO-*d*₆): δ = 169.0, 153.6, 148.5, 136.8, 133.0, 131.9, 129.8, 128.8, 128.3, 127.9, 127.3, 126.5, 123.8, 122.4, 122.3, 118.3, 116.0, 45.5, 22.1.

N-[(3-Nitro-phenyl)-(2-hydroxynaphthalen-1-yl)methyl]acetamide (**f**). ¹H NMR (400 MHz, DMSO-*d*₆): δ = 2.04 (s, 3H), 7.27 (m, 3H), 7.43 (t, *J* = 7.2 Hz, 1H), 7.57 (m, 2H), 7.86 (m, 3H), 8.03 (s, 1H), 8.06 (m, 1H), 8.65 (d, *J* = 8.0 Hz, 1H), 10.17 (s, 1H); ¹³C NMR (100 MHz, DMSO-*d*₆): δ = 23, 48.1, 118.3, 118.9, 120.9, 121.7, 123.1, 123.3, 127.3, 128.9, 129.2, 130.1, 130.4, 132.6, 133.3, 145.9, 148.2, 153.8, 170.2.

N-[(2-Hydroxynaphthalen-1-yl)-(3-hydroxyphenyl)methyl]acetamide (**g**). ¹H NMR (400 MHz, DMSO-*d*₆): δ = 1.97 (s, 3H), 7.01–7.36 (m, 6H), 7.75–7.81 (m, 4H), 8.39 (d, *J* = 8.0 Hz, 1H), 9.19 (s, 1H), 9.96 (s, 1H).

N-[(2-Hydroxynaphthalen-1-yl)-(4-hydroxyphenyl)methyl]acetamide (**h**). ¹H NMR (400 MHz, DMSO-*d*₆): δ = 1.96 (s, 3H), 7.0–7.45 (m, 6H), 7.78–7.83 (m, 2H), 8.49 (d, *J* = 8.0 Hz, 1H), 9.19 (s, 1H), 10.11 (s, 1H).

N-[(2-Hydroxynaphthalen-1-yl)-(4-ethoxyphenyl)methyl]acetamide (**i**). ¹H NMR (400 MHz, DMSO-*d*₆): δ = 9.98 (s, 1H), 8.42 (d, *J* = 8.0 Hz, 1H), 7.74–7.81 (m, 2H), 6.78–7.37 (m, 6H), 3.94 (q, 2H), 1.96 (s, 3H), 1.28 (t, 3H); ¹³C NMR (100 MHz, DMSO-*d*₆): δ = 169.0, 156.8, 153.0, 134.2, 132.2, 129.0, 128.4, 128.4, 127.1, 126.1, 123.3, 122.3, 118.9, 118.4, 113.8, 62.8, 47.3, 22.6, 14.6.

N-[(4-Methyl-phenyl)-(2-hydroxynaphthalen-1-yl)methyl]acetamide (**j**). ¹H NMR (400 MHz, DMSO-*d*₆): δ = 1.99 (s, 3H), 2.24 (s, 3H), 7.1 (s, 1H), 7.23 (d, 1H), 7.24 (d, 4H), 7.26 (m, 1H), 7.75 (m, 1H), 7.78 (d, 1H), 7.79 (d, 1H), 7.82 (d, 1H), 8.44 (s, 1H), 9.98 (s, 1H); ¹³C NMR (100 MHz, DMSO-*d*₆): δ = 47.61, 118.46, 118.98, 122.32, 125.97, 126.21, 129.1, 128.51, 132.3, 134.9,

Scheme 1. Preparation of melamine-Br₃.

139.55, 153.07, 169.14.

N-((4-Chlorophenyl)-(2-hydroxynaphthalen-1-yl)methyl)ethanethioamide (**k**). ^1H NMR (400 MHz, DMSO-d_6): δ = 2.06 (s, 3H), 7.14–7.40 (m, 8H), 7.79–7.83 (m, 3H), 8.53 (d, 1H), 10.13 (s, 1H); ^{13}C NMR (100 MHz, DMSO-d_6): δ = 23.0, 47.8, 118.7, 118.9, 122.9, 123.6, 126.9, 128.3, 128.4, 129.1, 130.0, 131.1, 132.6, 142.2, 153.5, 153.6, 169.9.

N-((4-Bromo-phenyl)-(2-hydroxy-naphthalen-1-yl)-methyl)-thioacetamide (**l**). ^1H NMR (400 MHz, DMSO-d_6): δ = 2.0 (s, 3H), 7.10 (m, 3H), 7.23–7.30 (m, 2H), 7.38 (d, J = 7.6 Hz, 1H), 7.45–7.47 (m, 2H), 7.80 (m, 3H), 8.49 (d, J = 8.4 Hz, 1H), 10.07 (s, 1H); ^1H NMR (400 MHz, $\text{DMSO-d}_6 + \text{D}_2\text{O}$): δ = 1.98 (s, 3H), 7.1–7.6 (m, 3H), 7.21 (m, 1H), 7.24–7.28 (m, 1H), 7.39–7.43 (m, 3H), 7.76–7.80 (m, 3H). ^{13}C NMR (100 MHz, DMSO-d_6): δ = 23.1, 47.9, 118.8, 118.9, 119.5, 123.123.7, 127, 128.8, 129, 129.1, 130, 131.3, 132.7, 142.7, 153.7, 170.

N-((2-Hydroxynaphthalen-1-yl)-(p-tolyl)methyl)ethanethioamide (**m**). ^1H NMR (400 MHz, solvent): δ = 1.99 (s, 3H), 2.23 (s, 3H), 7.06 (s, 1H), 7.35–7.38 (m, 6H), 7.76–7.84 (m, 4H), 8.46 (s, 1H), 10.03 (s, 1H); ^{13}C NMR (100 MHz, DMSO-d_6): δ = 21.0, 23.0, 48.9, 118.8, 118.9, 119.3, 119.4, 122.8, 123.8, 126.4, 129.0, 129.6, 132.7, 135.5, 139.9, 153.4, 169.7.

N-((3-Nitro-phenyl)-(2-hydroxynaphthalen-1-yl)methyl)thioacetamide (**n**). (Table 1, Entry 14) ^1H NMR (400 MHz, DMSO-d_6): δ = 2.04 (s, 3H), 7.19–7.25 (m, 2H), 7.31 (m, 1H), 7.43 (m, 1H), 7.55–7.60 (m, 2H), 7.82–7.86 (m, 4H), 8.03–8.08 (m, 2H), 8.65 (d, J = 8.0 Hz, 1H), 10.16 (s, 1H); ^1H NMR (400 MHz, $\text{DMSO-d}_6 + \text{D}_2\text{O}$): δ = 2.01 (s, 3H), 7.15 (s, 1H), 7.2 (d, J = 8.8 Hz, 1H), 7.3 (m, 1H), 7.42 (m, 1H), 7.54 (m, 1H), 7.6 (d, J = 8.0 Hz, 1H), 7.79–7.87 (m, 2H), 7.9 (s, 1H), 8.02–8.04 (m, 1H); ^{13}C NMR (100 MHz, DMSO-d_6): δ = 23, 48, 118.3, 118.9, 120.9, 121.7, 123.1, 123.3, 127.2, 128.9, 129.2, 130.1, 130.4, 132.6, 133.3, 145.9, 148.2, 153.8, 170.2.

N-((5-Bromo-2-hydroxy-phenyl)-(2-hydroxynaphthalen-1-yl)methyl)thioacetamide (**o**). ^1H NMR (400 MHz, DMSO-d_6): δ = 1.92 (s, 3H), 6.66 (d, J = 8.8 Hz, 1H), 7.12–7.20 (m, 3H), 7.27 (m, J = 14.8 Hz, 1H), 7.44 (m, J = 14.8 Hz, 1H), 7.60 (s, 1H), 7.71 (d, J = 8.8 Hz, 1H), 7.78 (d, J = 8.0 Hz, 1H), 8.20 (d, J = 8.8 Hz, 1H), 8.44 (d, J = 8.4 Hz, 1H), 9.70 (s, 1H), 9.91 (s, 1H); ^1H NMR (400 MHz, $\text{DMSO-d}_6 + \text{D}_2\text{O}$): δ = 1.88 (s, 3H), 6.68 (d, J = 8.8 Hz, 1H), 7.10–7.18 (m, 3H), 7.27 (m, 1H), 7.39–7.46 (m, 2H), 7.71 (d, J = 8.8 Hz, 1H), 7.76 (d, J = 8.0 Hz, 1H), 8.10 (d, J = 8.8 Hz, 1H); ^{13}C NMR (100 MHz, DMSO-d_6): δ = 23.1, 44.9, 110, 117.4, 119, 119.1, 122.7, 123.7, 126.5, 128.6, 128.8, 129.3, 130.3, 131.7, 131.8, 133.1, 153.7, 154.3, 169.0.

N-((4-(Acetylamino(2-hydroxynaphthalen-1-yl)methyl)phenyl)-(2-hydroxynaphthalen-1-yl)methyl)acetamide (**A**). White solid; m.p.: 280–282 °C (277–279 °C [27]); ^1H NMR (400

MHz, DMSO-d_6): δ = 9.96 (s, 2H), 8.38 (d, J = 8.0 Hz, 2H), 7.73–7.81 (m, 4H), 7.04–7.34 (m, 12H), 1.92 (s, 6H); ^{13}C NMR (100 MHz, DMSO-d_6): δ = 140.3, 132.2, 129.1, 128.4, 128.3, 126.2, 125.7, 122.3, 118.7, 118.6, 118.3, 118.2, 118.2, 47.6, 22.5.

3. Results and discussion

In a continuation of our ongoing research towards the development of novel transformation in organic synthesis using halogenating agents [26,28,29], we have developed a process for the construction of 1-amidoalkyl-2-naphthols using melamine- Br_3 as an efficient catalyst. The reaction of benzaldehyde with 2-naphthol and acetamide was initially selected as a model transformation (Scheme 2) to optimized the reaction conditions.

As shown in Table 1, when the reaction was initially conducted in the absence of the catalyst, only a small amount of the product was formed over a long reaction time. The addition of 0.05 mmol of catalyst led to a significant increase in the yield (70%) with the reaction time being reduced to 6.5 h. Increasing the catalyst amount from 0.05 to 0.15 mmol continuously, the product yield was increased, and the reaction time was reduced. Further increasing the catalyst amount to 0.20 mmol, however, led to a reduction in the product yield and an increase in the reaction time. 0.15 mmol of catalyst therefore gave the best results.

To determine the effect of temperature on the reaction, we evaluated the condensation reaction of 2-naphthol with acetamide and benzaldehyde in the presence of melamine- Br_3 at a variety of different temperatures. As shown in Fig. 1, when the reaction temperature was varied from room temperature to 130 °C, the product yield gradually increased, with the highest yield being obtained at 130 °C.

With the optimized conditions (i.e., 2-naphthol 1 mmol, arylaldehyde 1 mmol, amide 1.5 mmol, melamine- Br_3 0.15 mmol, 130 °C), we proceeded to evaluate the scope of the reaction by preparing a variety of different amidoalkyl naphthols (Table 2).

From Table 2, it is clear that aromatic aldehydes bearing either an electron-donating or electron-withdrawing group pro-

Table 1

The effect of catalyst amounts on the reaction of 2-naphthol with acetamide and benzaldehyde at 130 °C

Catalyst amount (mmol)	Time (h)	Isolated yield (%)
0.00	24	17
0.05	6.5	70
0.10	4.5	86
0.15	2.5	95
0.20	6	80

Scheme 2. Preparation of *N*-((2-hydroxynaphthalen-1-yl)-(phenyl)methyl)acetamide.

Fig. 1. The effect of temperature on the reaction of 2-naphthol with acetamide and benzaldehyde.

ceeded smoothly under the optimized conditions to give the desired products in good yields. Aromatic aldehydes bearing an electron-donating group, however, gave a slightly lower yield and required longer reaction time (Table 2, entries 7–10). The optimized method also proceeded successfully when thioacetamide was used instead of acetamide in the reaction (Table 2, entries 11–16).

The presence of an electron-withdrawing group on the benzaldehyde led to an increase in the rate of the 1,4-nucleophilic addition reaction of the *o*-quinone methide (*o*-QM) intermediates because the electron-withdrawing group led to a reduction in the energy of the lowest unoccupied molecular orbital of the alkene.

The nature of the substituent on the aromatic aldehyde did not appear to have a significant effect on the product yield, with electron-donating and electron-withdrawing substituents both providing good to excellent yields of the corresponding products, although sterically hindered aromatic aldehydes required longer reaction time.

Based on our results and related reports from the literature [25], we have proposed a mechanism for the transformation which is shown in Scheme 3.

The reaction is believed to proceed via the formation of an *o*-QM intermediate. Nucleophilic conjugate addition of the amide to the *o*-QM intermediate would lead to the formation of the amidoalkynaphthol product in excellent yields. In this reaction, the melamine-Br₃ could act as a bifunctional catalyst [27,30,31], in that it would activate both the carbonyl oxygen in the aldehyde and the acidic hydrogen in 2-naphthol. Since melamine-Br₃ contains Br atoms that are attached to N atoms, it is likely that Br⁺ would be released *in situ*, and that this species would act as a catalyst in the reaction medium; leading to a considerable increase in the electrophilicity of the aldehyde. The reaction would proceed *via* the formation of an *o*-QM intermediate, which would be formed via the nucleophilic addition of 2-naphthol to the aldehyde. The *o*-QM intermediate would then react with acetamide or thioacetamide to produce the desired 1-amidoalkyl-2-naphthol product.

The reaction was also studied using the bis-aldehyde terphthalaldehyde with 2-naphthol and acetamide (Scheme 4).

When the 2-naphthol (2.5 mmol) and the aldehyde (1

Table 2

Synthesis of 1-amido or thio alkyl-2-naphthols catalyzed by melamine-Br₃.

Entry	Aldehyde	Amide	Product	Time (min)	Yield* (%)	M.P. (°C)
1		CH ₃ CONH ₂	a	150	95	244–245
2		CH ₃ CONH ₂	b	180	90	228–230
3		CH ₃ CONH ₂	c	200	92	230–232
4		CH ₃ CONH ₂	d	195	90	210–212
5		CH ₃ CONH ₂	e	210	90	188–190
6		CH ₃ CONH ₂	f	105	95	238–240
7		CH ₃ CONH ₂	g	240	85	227–229
8		CH ₃ CONH ₂	h	240	88	238–240
9		CH ₃ CONH ₂	i	330	85	218–220
10		CH ₃ CONH ₂	j	300	86	220–222
12		CH ₃ CSNH ₂	k	240	93	237–240
13		CH ₃ CSNH ₂	l	240	90	232–234
14		CH ₃ CSNH ₂	m	280	90	220–222
15		CH ₃ CSNH ₂	n	180	95	228–230
16		CH ₃ CSNH ₂	o	310	92	215–217

* Isolated yield following purified by column chromatography.

mmol) were reacted with acetamide (3.75 mmol) in the presence of melamine-Br₃ (0.15 mmol) at 130 °C for 2 h, bis-1-amidoalkyl-2-naphthol (**A**) was obtained in 95%.

The results of the current study were compared with those of several other reported procedures from the same transformation to demonstrate the effectiveness of our newly developed method (Table 3). It revealed that melamine-Br₃ was superior to other catalysts in terms of the product yields and/or the reaction time.

Scheme 3. Proposed mechanism for the construction of 1-amido or thio alkyl-2-naphthols.

Scheme 4. Synthesis of *N*-((4-(acetylamino(2-hydroxynaphthalen-1-yl)methyl)phenyl)-(2-hydroxynaphthalen-1-yl)methyl)acetamide.

Table 3

Comparison of different catalysts for the one-pot three-component reaction of aldehydes with 2-naphthol and acetamide.

Aldehyde	Catalyst	Time (min)	Isolated yield (%)	Ref.
	Melamine-Br ₃	150	95	this work
	Ce(SO ₄) ₂	2160	72	[9]
	PFPAT	360	90	[23]
	TBM	105	95	this work
	<i>p</i> -TSA	240	90	[18]
	SA	420	82	[8]
	TBM	180	90	this work
	PFPAT	300	95	[23]
	RuCl ₂ (PPh ₃) ₃	600	75	[6]

PFPAT—Pentafluorophenyl ammonium triflate; SA—Sulfamic acid; *p*-TSA—*p*-Toluenesulfonic acid.

4. Conclusions

A new catalytic procedure for the synthesis of 1-amidoalkyl-2-naphthol derivatives via the one-pot multi-component condensation of 2-naphthol with aromatic aldehydes and acetamide/thioacetamide under solvent-free conditions was developed using melamine-Br₃ as an efficient catalyst. There are several advantages to this procedure compared with the exist-

ing methodologies, including good yield and short reaction time. Furthermore, the catalytic system is environmentally benign and highly efficient, as well as being easy to prepare.

References

- [1] Wang Y F, Izawa T, Kobayashi S, Ohno M. *J Am Chem Soc*, 1982, 104: 6465
- [2] Knapp S. *Chem Rev*, 1995, 95: 1859
- [3] Shen A Y, Chen C L, Lin C I. *Chin J Physiol*, 1992, 35: 45
- [4] Szatmári I, Fülöp F. *Curr Org Synth*, 2004, 1: 155
- [5] Shen A Y, Tsai C T, Chen C L. *Eur J Med Chem*, 1999, 34: 877
- [6] Zhu X Y, Lee Y R, Kim S H. *Bull Korean Chem Soc*, 2012, 33: 2799
- [7] Nagawade R R, Shinde D B. *Chin J Chem*, 2007, 25: 1710
- [8] Patil S B, Singh P R, Surpur M P, Samant S D. *Ultrason Sonochem*, 2007, 14: 515
- [9] Selvam N P, Perumal P T. *Tetrahedron Lett*, 2006, 47: 7481
- [10] Rashinkar G, Salunkhe R. *J Mol Catal A*, 2010, 316: 146
- [11] Wang M, Liang Y, Zhang T T, Gao J J. *Chin Chem Lett*, 2012, 23: 65
- [12] Nagarapu L, Baseeruddin M, Apuri S, Kantevari S. *Catal Commun*, 2007, 8: 1729
- [13] Hong M, Cai C, Yi W B. *Chin Chem Lett*, 2011, 22: 322
- [14] Dorehgiraei A, Khabazzadeh H, Saidi K. *Arkivoc*, 2009, (7): 303
- [15] Kumar A, Rao M S, Ahmad I, Khungar B. *Can J Chem*, 2009, 87: 714
- [16] Shaterian H R, Yarahmadi H, Ghashang M. *Bioorg Med Chem Lett*,

Graphical Abstract

Chin. J. Catal., 2014, 35: 1024–1029 doi: 10.1016/S1872-2067(14)60029-2

One-pot synthesis of 1-amidoalkyl-2-naphthols catalyzed by melamine-Br₃ under solvent-free conditions

Arash Ghorbani-Choghamarani*, Shima Rashidimoghadam
Ilam University, Iran

Melamine-Br₃ has been shown to be an efficient and non-acidic catalyst for the condensation of 2-naphthol with aldehydes and acetamide or thioacetamide.

- 2008, 18: 788
- [17] Kantevari S, Vuppapapati S V N, Nagarapu L. *Catal Commun*, 2007, 8: 1857
- [18] Khodaei M M, Khosropour A R, Moghanian H. *Synlett*, 2006: 916
- [19] Supale A R, Gokavi G S. *J Chem Sci*, 2010, 122: 189
- [20] Mistry S R, Joshi R S, Maheria K C. *J Chem Sci*, 2011, 123: 427
- [21] Zhang P, Zhang Z H. *Monatsh Chem*, 2009, 140: 199
- [22] Das B, Laxminarayana K, Ravikanth B, Rao B R. *J Mol Catal A*, 2007, 261: 180
- [23] Khaksar S, Najafi R, Ostad S M, Tajbakhsh M. *World Appl Sci J*, 2012, 20: 656
- [24] Kiasat A R, Mouradzadegan A, Saghaneshad S J. *Chin J Catal* (催化学报), 2013, 34: 1861
- [25] Wu L Q. *Eur J Chem*, 2012, 9: 1035
- [26] Ghorbani-Choghamarani A, Zolfigol M A, Hajjami M, Jafari S. *J Chin Chem Soc*, 2008, 55: 1208
- [27] Zare A, Hasaninejad A, Rostami E, Moosavi-Zare A R, Pishahang N, Roshankar M, Khedri F, Khedri M. *Eur J Chem*, 2010, 7: 1162
- [28] Zolfigol M A, Ghorbani-Vaghei R, Mallakpour S, Chehardoli G, Ghorbani-Choghamarani A, Yazdi A H. *Synthesis*, 2006: 1631
- [29] Ghorbani-Choghamarani A, Amani K, Zolfigol M A, Hajjami M, Ayazi-Nasrabadi R. *J Chin Chem Soc*, 2009, 56: 255
- [30] Liu Y L, Shi T D, Zhou F, Zhao X L, Wang X, Zhou J. *Org Lett*, 2011, 13: 3826
- [31] Liu Y L, Zeng X P, Zhou J. *Chem Asian J*, 2012, 7: 1759
- [32] Liu Y L, Zhou J. *Chem Commun*, 2013, 49: 4421