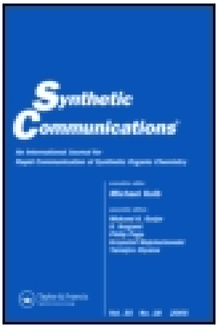

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$H_3Mo_{12}O_{40}P$-Catalyzed One-Pot Synthesis of Amidoalkyl Naphthols

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Arun Yadav,[2] and Atul Chaskar[1,3]
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Abstract: Solid $H_3Mo_{12}O_{40}P$ is used for an efficient one-pot synthesis of amidoalkyl naphthols using aromatic aldehydes, β-naphthol, and urea or amides in carbon tetrachloride. The catalyst was efficiently recovered from the reaction mixture and reused with negligible loss of catalyst activity. Ambient conditions, simple workup, and good yield are some of the striking features of the present protocol.

Keywords: Amidoalkyl naphthols, aryl aldehyde, β-naphthol, one-pot reaction, phosphomolybdic acid, urea or amides

INTRODUCTION

Multicomponent reactions (MCRs) have gained importance because of their merits over two-component reactions, including the simplicity of a one-pot procedure and wide variety of applications in organic and medicinal chemistry.[1] Because these MCRs are one-pot processes in which three or four accessible components react to form a single product, the results of the MCRs can be achieved in a very fast, efficient, and time-saving manner without isolation of any intermediate.[2] Recently, there has been development of three- and, four-component

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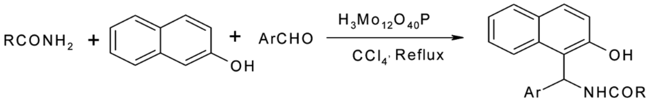


Scheme 1. Synthesis of amidoalkyl naphthol.

reactions: the Biginelli,[3] Ugi,[4] Passerini,[5] Bucherer–Bergs,[6] and Mannich[7] reactions.

Heteropolyacids (HPAs) are used as catalysts in various fine chemical processes.[8] Compared to conventional organic and inorganic acids, the HPAs are more active, as they have high acid strengths, low reducibility, and thermal stability. Along with these characteristics, they are noncorrosive and environmentally gentle. HPAs have attracted much interest in synthetic chemistry because of their easy workup and minimization of waste due to recyclability and reuse.[9] HPAs are used in various liquid-phase reactions such as alcohol dehydration, alkylation, and esterification reactions.

In continuation of our interest in exploring new catalytic activities of phosphomolybdic acid ($H_3Mo_{12}O_{40}P$) in MCRs, herein we report a simple and convenient method for the synthesis of amidoalkyl naphthols by condensation of β-naphthol, aryl aldehyde, and urea or amide in the presence of phosphomolybdic acid as a catalyst (Scheme 1).

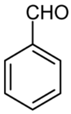
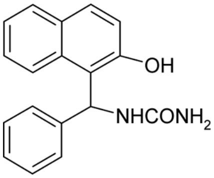
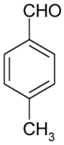
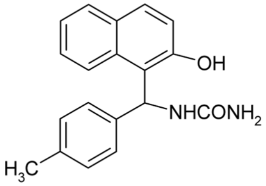
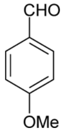
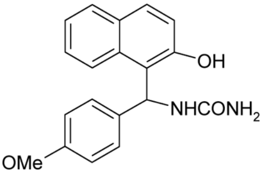
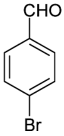
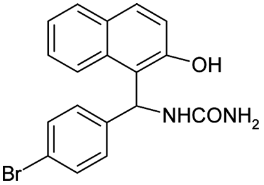
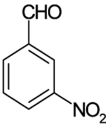
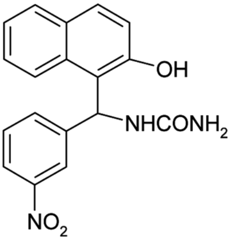
RESULTS AND DISCUSSION

We have studied the effect of various organic solvents on the yield and rate of the reaction. Organic solvents (viz. 1,4-dioxan, acetonitrile, methanol, carbon tetrachloride, dichloromethane, tetrahydrofuran,

Table 1. Solvent effect on reaction of benzaldehyde, β-naphthol, and benzamide catalyzed by $H_3Mo_{12}O_{40}P$

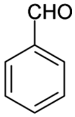
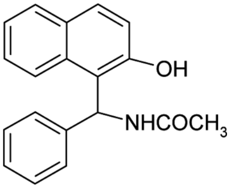
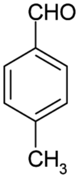
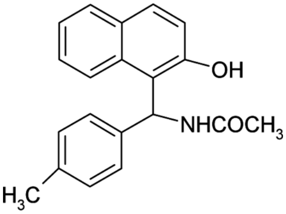
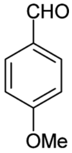
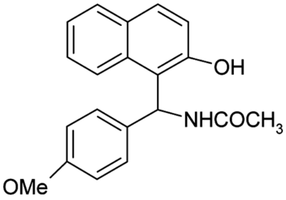
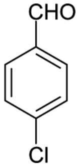
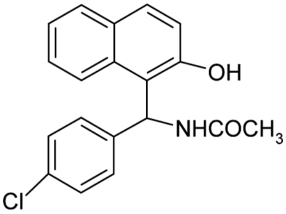
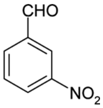
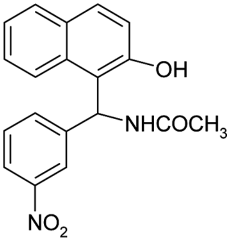
Entry	Solvent	Time (h)	Yield (%)
1	1,4-Dioxan	6	62
2	Acetonitrile	3	79
3	Methanol	5	68
4	Carbon tetrachloride	1.5	85
5	Dichloromethane	2	80
6	Tetrahydrofurane	5	65
7	Chloroform	3	72
8	Ethylene dichloride	2	83

Table 2. Synthesis of amido alkyl naphthols in the presence of catalytic amounts of $H_3Mo_{12}O_{40}P$

Entry	Aldehyde	Urea/amide	Product	Time (h)	Yield (%)
1		$H_2N{-}CO{-}NH_2$		1.5	85
2		$H_2N{-}CO{-}NH_2$		2.5	82
3		$H_2N{-}CO{-}NH_2$		2	83
4		$H_2N{-}CO{-}NH_2$		4	80
5		$H_2N{-}CO{-}NH_2$		2	84

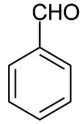
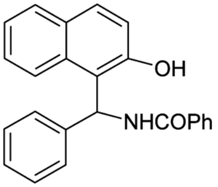
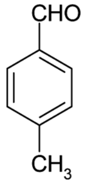
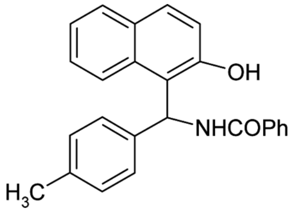
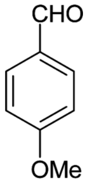
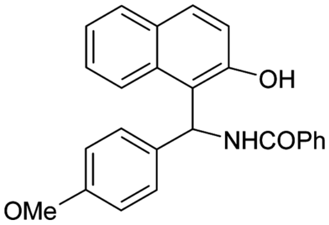
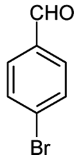
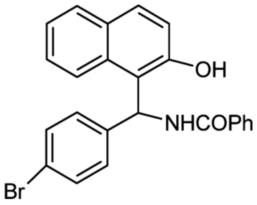
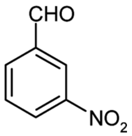
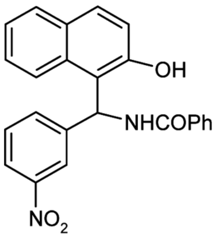
(*Continued*)

Table 2. Continued

Entry	Aldehyde	Urea/amide	Product	Time (h)	Yield (%)
6		$H_3C{-}CO{-}NH_2$		1.5	84
7		$H_3C{-}CO{-}NH_2$		3	81
8		$H_3C{-}CO{-}NH_2$		2.5	82
9		$H_3C{-}CO{-}NH_2$		3.5	81
10		$H_3C{-}CO{-}NH_2$		2	83

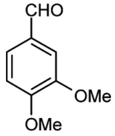
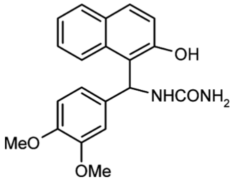
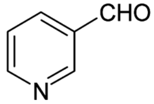
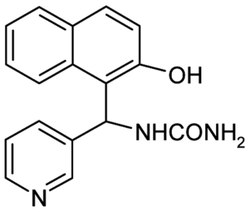
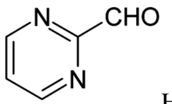
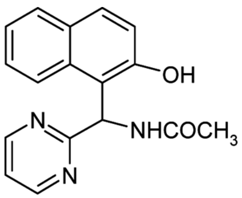
(*Continued*)

Table 2. Continued

Entry	Aldehyde	Urea/amide	Product	Time (h)	Yield (%)
11		$Ph-CO-NH_2$		2	84
12		$Ph-CO-NH_2$		3	82
13		$Ph-CO-NH_2$		3	83
14		$Ph-CO-NH_2$		4	79
15		$Ph-CO-NH_2$		3	81

(*Continued*)

Table 2. Continued

Entry	Aldehyde	Urea/amide	Product	Time (h)	Yield (%)
16		$H_2N{-}CO{-}NH_2$		3	79
17		$H_2N{-}CO{-}NH_2$		2.5	85
18		$H_3C{-}CO{-}NH_2$		2.5	78

chloroform, and ethylene dichloride) were selected for the study. The best result was obtained with carbon tetrachloride (Table 1).

Various aromatic aldehydes were refluxed with β-naphthol and urea or amides in CCl_4, in the presence of a catalytic amount of $H_3Mo_{12}O_{40}P$. The corresponding amido alkyl naphthols were obtained in good to excellent yield. The results are summarized in Table 2.

The aromatic aldehyde with an electron-withdrawing group reacted much faster than the aromatic aldehyde bearing an electron-donating group. However, the type of the substituent on the aromatic aldehydes does not show much effect on the yield of the product. The electron-donating as well as electron-withdrawing substituents on the aromatic ring resulted in good to excellent yields.

The effectiveness of catalyst was investigated. The reactions of para-substituted aromatic aldehyde such as p-methylbenzadehyde, p-methoxybenzaldehyde, and m-nitrobenzaldehyde were studied, and reactions resulted in good yield with enhanced rate of reaction without any side products.

CONCLUSION

In conclusion, a one-pot, simple, and efficient process to afford diversified amidoalkyl naphthols via three-component reaction of β-naphthol, aryl aldehyde, and urea or amide using phosphomolybdic acid as catalyst was developed. The process has several advantages over reported literature from economical and environmental points of view, such as operational simplicity, mild reaction conditions, good yield of the product, recyclability, and reuse of catalyst.

EXPERIMENTAL

All commercial reagents are used as received without purification, and all solvents were reagent grade. The reaction mixture was stirred magnetically in a round-bottomed flask and was monitored by thin-layer chromatography (TLC) using 0.25-mm Merck silica-gel 60 F_{254} precoated plates, which were visualized with ultra violet (UV) light. Melting points were taken in open capillaries. The infrared (IR) spectra were recorded on a Perkin-Elmer 257 spectrometer using KBr discs. ^1H NMR and ^{13}C NMR spectra in dimethyl sulfoxide (DMSO-d_6) were recorded on a VXR 300-MHz instrument using tetramethylsilane (TMS) as internal standard.

General Experimental Procedure

A mixture of aromatic aldehyde (1 mmol), β-naphthol (1 mmol), urea or amides (1 mmol), and phosphomolebdic acid (0.0002 mol) in CCl_4 was refluxed for the appropriate time as indicated in Table 2. After completion of reaction, as indicated by TLC, the solvent was removed under pressure. The solid was washed with water and recrystallized from ethanol.

Representative Spectral Data (11)

IR (KBr): 3385, 2900, 1640, 1530, 1418, 1320, 1259, 1060, 978, 815 cm^{-1}. ^1H NMR (DMSO-d_6 δ-ppm): 5.1 (s, 1H, OH), 6.79 (s, 1H), 6.98 (d, 1H), 7.20–7.50 (m, 15H), 7.8 (s, 1H, NH). CMR (DMSO-d_6 δ-ppm): 167, 153.5, 138, 135, 134, 132.50, 131, 130, 129, 128.80, 128.40, 128, 127.50, 127, 126.50, 126, 125.80, 125.50, 125, 124.50, 122, 119, 115, 54.

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