

Short communication

A simple and facile synthesis of homoallylic amines using silica supported sodium hydrogen sulfate[☆]

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Abstract

Silica supported sodium hydrogen sulphate ($\text{NaHSO}_4 \cdot \text{SiO}_2$) catalyzes efficiently the three-component reactions of aldehydes, amines and allyltributylstannane to form the corresponding homoallylic amines at room temperature. The catalyst is inexpensive and eco-friendly and works under heterogeneous conditions.

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Keywords: Homoallylic amine; Three-component reaction; Silica supported sodium hydrogen sulfate; Heterogeneous catalyst

Homoallylic amines are generally synthesized by allylation of imines with allyl organometallics in the presence of a catalyst such as TiCl_4 , $\text{BF}_3 \cdot \text{OEt}_2$, $\text{PdCl}_2(\text{Ph}_3\text{P})_2$ or $\text{PtCl}_2(\text{Ph}_3\text{P})_2$ [1,2]. The in situ generation of imines from aldehydes and amines followed by allylation can conveniently be utilized for one-pot preparation of these compounds [3]. In continuation of our work [4] on the application of silica supported sodium hydrogen sulphate ($\text{NaHSO}_4 \cdot \text{SiO}_2$) as a heterogeneous catalyst for development of useful synthetic methodologies we have currently observed that it can catalyze effectively the three-component reactions of aldehydes, amines and allyltributylstannane to produce the corresponding homoallylic amines at room temperature (Scheme 1).

Heterogeneous catalysts have gained much importance in recent years due to economic and environmental considerations [4]. These catalysts are generally less expensive, highly reactive, eco-friendly and convenient to handle. Multicomponent reactions have also recently attracted a considerable attention in organic syntheses as they can produce the target products in a single operation without isolating the intermediates and thus reducing the reaction times and energy [5]. In the present synthesis of homoallylic amines $\text{NaHSO}_4 \cdot \text{SiO}_2$, a simple heterogeneous catalyst has efficiently been applied for the three-

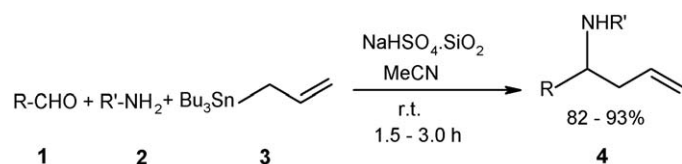
component reactions of aldehydes, amines and allyltributylstannane. The catalyst can easily be prepared [6] from the readily available inexpensive ingredients, NaHSO_4 and silica gel (finer than 200 mesh) and it should be properly activated. The reaction conditions using this catalyst is very mild and the experimental procedure is very simple.

Various aldehydes and amines (for in situ formation of imines) and allyltributylstannane were used to produce a series of homoallylic amines (Table 1). The products were formed within 1.5–3.0 h and in high yields. Aromatic, heteroaromatic and aliphatic aldehydes underwent the conversion smoothly. The aromatic aldehydes containing both electron-donating and electron-withdrawing groups in the aromatic ring worked well. However, ketones did not form any product under similar reaction conditions. Homoallylic alcohols (adducts between aldehydes and allyltributylstannane) were also not formed. This is due to the rapid formation and activation of imines under the influence of the catalyst. In absence of this catalyst only a trace amount of homoallylic amines could be detected even after 2 h. With only NaHSO_4 or silica gel the yields of the products were also low.

In conclusion, we have developed a novel, simple and efficient protocol for the synthesis of homoallylic amines using $\text{NaHSO}_4 \cdot \text{SiO}_2$ as a catalyst. The method is associated with the benefits derived from multicomponent reaction and the application of a heterogeneous catalyst. We feel this eco-friendly and economically viable catalyst will find practical utility for the one-pot synthesis of homoallylic amines.

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Scheme 1.

1. Experimental

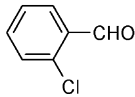
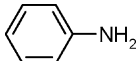
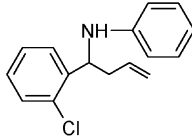
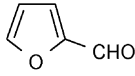
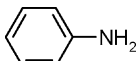
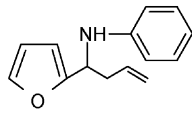
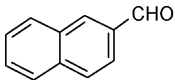
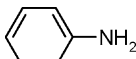
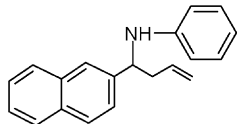
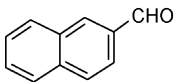
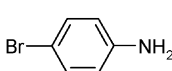
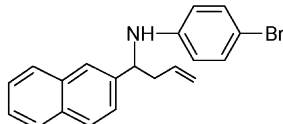
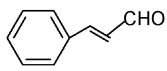
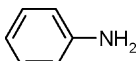
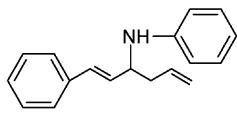

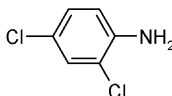
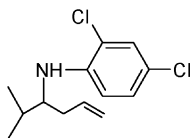
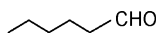
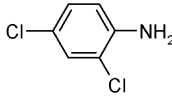
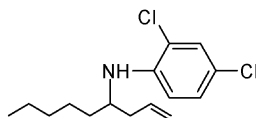
1.1. General procedure for the synthesis of homoallylic amine

To a mixture of an aldehyde (1 mmol), amine (1 mmol) and allyltributylstannane (1.2 mmol) in MeCN (5 ml) NaHSO₄·SiO₂ (200 mg) was added. The mixture was stirred at room temperature and the reaction was monitored by TLC. After completion the mixture was filtered. The filtrate was concentrated and the

Table 1
A simple and facile synthesis of homoallylic amines using silica supported sodium hydrogen sulfate^a

Sl. no.	Aldehyde (1)	Amine (2)	Product (4)	Time (h)	Isolated yield (%)
a				1.5	90
b				2.0	88
c				2.0	92
d				2.5	90
e				2.75	87
f				2.25	93
g				3.0	85
h				3.0	83
i				1.5	93
j				2.5	87

Table 1 (Continued)

Sl. no.	Aldehyde (1)	Amine (2)	Product (4)	Time (h)	Isolated yield (%)
k				2.0	91
l				2.0	88
m				2.25	90
n				2.5	86
o				2.75	83
p				3.0	82
q				3.0	85

^a The structures of the prepared homoallylic amines were settled from their spectral (¹H NMR and MS) data.

gummy residue was purified by column chromatography over silica gel using hexane as eluent to obtain pure homoallylic amine.

The spectral (¹H NMR and MS) data of some representative compounds are given below.

Compound **4d**: ¹H NMR (200 MHz, CDCl₃): δ: 7.36–7.15 (5H, m), 6.60 (2H, d, *J* = 8.0 Hz), 6.37 (2H, d, *J* = 8.0 Hz), 5.74 (1H, m), 5.21–5.10 (2H, m), 4.28 (1H, m), 3.89 (1H, brs), 3.63 (3H, s), 2.62–2.41 (2H, m); FABMS: *m/z* 254 [*M*[•] + H]⁺.

Compound **4g**: ¹H NMR (200 MHz, CDCl₃): δ: 8.19 (2H, d, *J* = 8.0 Hz), 7.52 (2H, d, *J* = 8.0 Hz), 7.01 (2H, t, *J* = 8.0 Hz), 6.63 (1H, t, *J* = 8.0 Hz), 6.36 (2H, t, *J* = 8.0 Hz), 5.71 (1H, m), 5.29–5.15 (2H, m), 4.44 (1H, m), 4.12 (1H, brs), 2.58–2.38 (2H, m); FABMS: *m/z* 269 [*M*[•] + H]⁺.

Compound **4l**: ¹H NMR (200 MHz, CDCl₃): δ: 7.30 (1H, d, *J* = 1.8 Hz), 7.06 (2H, t, *J* = 8.0 Hz), 6.64 (1H, t, *J* = 8.0 Hz), 6.52 (2H, d, *J* = 8.0 Hz), 6.23 (1H, dd, *J* = 2.0, 1.8 Hz), 6.09 (1H, d, *J* = 2.0 Hz), 5.72 (1H, m), 5.20–5.08 (2H, m), 4.52 (1H, t, *J* = 5.5 Hz), 3.89 (1H, brs), 2.64 (2H, t, *J* = 5.5 Hz); FABMS: *m/z* 214 [*M*[•] + H]⁺.

Compound **4q**: ¹H NMR (200 MHz, CDCl₃): δ: 7.52 (1H, d, *J* = 2.0 Hz), 7.21 (1H, dd, *J* = 8.0, 2.0 Hz), 6.45 (1H, d,

J = 8.0 Hz), 5.76 (1H, m), 5.12–5.03 (2H, m), 4.13 (1H, d, *J* = 5.5 Hz), 3.38 (1H, m), 2.30 (1H, t, *J* = 5.5 Hz), 1.61–1.42 (2H, m), 1.37–1.14 (7H, m), 0.83 (3H, t, *J* = 7.0 Hz); FABMS: *m/z* 290, 288, 286 [*M*[•] + H]⁺.

Acknowledgements

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