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Communication

Magnetic nanoparticles supported cinchona alkaloids for asymmetric Michael addition reaction of 1,3-dicarbonyls and maleimides

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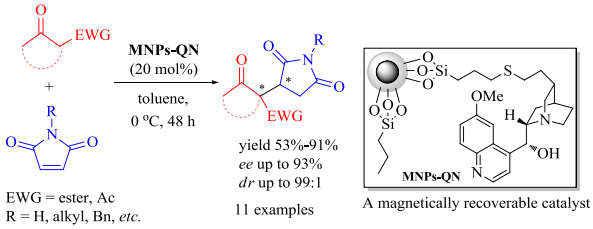
Graphical abstract



New magnetically recoverable cinchona alkaloid organocatalysts have been successfully developed for the asymmetric Michael addition reaction of 1,3-dicarbonyls and maleimides.

ABSTRACT
Magnetic nanoparticles Fe_3O_4@SiO_2 supported cinchona alkaloids (quinine and quinidine) were successfully synthesized as magnetically recoverable organocatalysts and characterized by FT-IR, XPS, SEM measurements, and elemental analysis. Their catalytic activity and stereoselectivity were preliminarily evaluated in the asymmetric Michael addition reaction of 1,3-dicarbonyls and maleimides. The supported quinine catalyst exhibited good catalytic efficiency and modest to high enantioselectivity. The magnetic recoverability and recyclability of the catalyst were also examined.

Keywords:
Magnetic nanoparticles
Cinchona alkaloids
Immobilization
Michael addition
Asymmetric catalysis

Over the past two decades, natural cinchona alkaloids and their derivatives have emerged as prevailing chiral organocatalysts and been widely utilized in a growing number of asymmetric organic reactions [1–8]. As homogeneous organocatalysts, cinchona catalysts encounter at least two challenging issues: separation and recycling of the catalyst and the relatively large amount of the catalyst loading. Immobilization of a homogeneous catalyst on a retrievable support is generally considered to be a simple and practical strategy to solve such issues. Heterogenization of cinchona catalysts has therefore attracted significant attention [9–21]. Typical solid supports like polymers, silica have already been utilized to prepare the immobilized cinchona organocatalysts, which can be separated by conventional separation techniques such as filtration and centrifugation.

Recently, magnetic nanoparticles (MNPs) as salient catalyst supports have attracted much attention [22–25]. Owing to their nano-scale nature and high surface area, MNPs-supported catalysts can act in a *quasi*-homogeneous manner. Also, the magnetic nature of the MNPs support enables the immobilized catalyst to be easily separated from the reaction mixture by simple decantation with the aid of external magnets, instead of tedious centrifugation and filtration. The use of MNPs in the immobilization of cinchona organocatalysts has also drawn some recent interest [26–28]. The 9-amino-9-deoxy-epiquinine-derived urea, thiourea, and amide organocatalysts [26, 27] and 9-amino-9-deoxy-epicinchonidine catalyst [28] were successfully immobilized on Fe_3O_4 MNPs and the corresponding MNPs-supported catalysts were used as recoverable organocatalysts in the asymmetric aldol, Diels-Alder, and Michael reactions with moderate to excellent enantioselectivities achieved. To the best of our knowledge, other MNPs-immobilized cinchona organocatalysts have not been explored yet. In this communication, we report the synthesis of new MNPs-supported cinchona alkaloids such as quinine and quinidine and their application in the asymmetric Michael addition reaction of 1,3-dicarbonyls and maleimides.

Synthesis of MNPs-supported cinchona alkaloids was illustrated in Scheme 1 (for experimental detail, see Supporting information). Magnetic nanoparticles silica-coated Fe_3O_4 were readily prepared by the well documented methods [26, 29, 30]. 3-Mercaptopropyltrimethoxysilane was chosen as a preferred linker agent between the MNPs support Fe_3O_4@SiO_2 and cinchona alkaloid.

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