1. Introduction

The conjugate reaction of various amines with \(\alpha,\beta\)-unsaturated carbonyl compounds provides \(\beta\)-amino carbonyl ingredients, which have attracted great attention in the synthesis of biological active molecules and some essential intermediates of antibiotics and pharmaceutical products.\(^1\)-\(^6\) The conjugate addition of amines to \(\alpha,\beta\)-unsaturated compounds is known as an atom economic aza-Michael reaction and is very simple to carry out. Generally, aza-Michael addition proceeds in the presence of strong acids or bases and some side products are formed. Thus, chemists have paid more attention to the development of milder catalytic systems. A number of homogeneous aza-Michael reaction catalysts such as AlCl\(_3\),\(^7\) PtCl\(_4\)/5H\(_2\)O,\(^8\) InCl\(_3\)/TMSCl,\(^9\) Bi(NO\(_3\))\(_3\),\(^10\) samarium iodobinaphtholate,\(^11\) boric acid,\(^12\) [Ni(PP)](THF)(ClO\(_4\))\(_2\),\(^13\) Pd(N\(_2\)N\(_2\)-ppo)Cl\(_2\),\(^14\) ionic liquids,\(^15\)-\(^18\) and TMSCl-promoted transition metals\(^19\) have been reported. The loss of material and difficulty of purification in each step of the reaction will dramatically reduce the overall efficiency of a synthetic process. Thus, not only the catalytic activity and selectivity but also the stability and reusability for safe, non-toxic, sustainable chemistry and green organic synthesis, have become particular interests in the development of heterogeneous metal catalysts. Therefore, the development of a perfect heterogeneous metal catalyst that meets the reactivity, selectivity, broad applicability and reusability criteria of a perfect catalyst is highly desirable. In this context, a lot of heterogeneous metal catalysts are employed. For instance, MOF-99,\(^20\) a polystyrene supported Cu/iminodiazole complex,\(^21\) biomaterial supported organo-catalyst,\(^22\) silica sulfuric acid,\(^23\) phosphate impregnated titania,\(^24\) nanocrystalline copper(ni) oxide,\(^25\) PANI–Cu,\(^26\) PANI–In,\(^27\) PSSA,\(^28\) Amberlyst-15,\(^29\) cellulose–Cu(0),\(^30\) CeCl\(_3\)/7H\(_2\)O/NaI/Al\(_2\)O\(_3\),\(^31\) polystyrene–AlCl\(_3\),\(^32\) and enzymes\(^33\),\(^34\) showed good catalytic activity for Michael additions. Although many economic and sustainable protocols have been employed by researchers dedicated to the development of green processes for aza-Michael additions, some of the catalysts have poor or even weak catalytic effects.\(^15\)-\(^17\)

Recently, scientists have been searching for cheap and more environmentally friendly sustainable resources and processes. In this context, cellulose, which is widely abundant in nature, would be the most acceptable material. The development of bio-based materials and composites could be a promising solution both in terms of environmental and performance aspects. The structure of biopolymers provides several advantages such as a low density and cost, a bio-renewable character, ubiquitous availability and interesting mechanical properties compared with glass fibres.\(^38\) Thus, natural celluloses would be highly desirable, attractive candidates to explore as the solid support for catalysts.\(^39\) Cellulose has interesting features, for example, a high sorption capacity, stability, and physical and chemical versatility, making it attractive for use as supports. Cellulose can be chemically modified and effective chelating ligands can be introduced onto the cellulose backbone.\(^40\),\(^41\) Recently, several biopolymers, for example alginate,\(^42\) gelatin,\(^43\) starch\(^44\) and chitosan\(^45\) derivatives, have been utilized as a support for catalytic applications. Thus, the development of a general, simple and convenient method, which can be applied to a number of substrates of different natures in a catalytic process under milder and environmentally friendly conditions,