Abstract

The first part of the thesis is focused on the design, synthesis, evaluation, and application of novel bifunctional (thio)urea organocatalysts derived from saccharides. Combination of H-bonding donor (thio)urea moiety with Lewis base active site in a single chiral scaffold (e.g., 1,2-*trans*-cyclohexyl, cinchona alkaloids, 1,1'-binaphthyl) is a popular motif in catalyst design. Only limited attention has been paid to the synthesis of bifunctional (thio)ureas using saccharides as a chiral scaffold. Saccharides bring the advantage of the availability of various diastereomeric forms. Moreover, they offer modification of steric, electronic, and solubility properties *via* *O*-substitution. Three types of novel organocatalysts were designed: C2-symmetrical thiourea/tertiary amines entirely derived from 2-amino-2-deoxy saccharides, thiourea/primary amines based on pentopyranose and a cyclohexane skeleton, and (thio)urea/tertiary phosphines containing both saccharide and α-amino acid unit.

Both functional groups of organocatalysts of the first type are located on the saccharide unit, and it is the only element which fully determines stereoselectivity. This is an exceptional approach as the majority of saccharide-based organocatalysts use saccharide as a bulky electron-withdrawing substituent. However, the route to these catalysts was hindered by the interference of *O*- and/or *N*-protecting groups with the chosen synthetic steps. Organocatalyst of the second type derived from D-xylopyranose (a structural analogue of the proven glucopyranose unit) was successfully synthesized. Bifunctional organocatalysts of the third type are readily available from naturally occurring molecules: saccharides and amino acids. The availability of various natural and synthetic α-amino acids enables further modification of catalyst properties to tune the stereocontrol. The efficiency of organocatalysts of the third type was demonstrated in the asymmetric Morita-Baylis-Hillman (MBH) reaction of aromatic aldehydes with acrylates. The corresponding MBH products were obtained in good yields (up to 85%) with high enantioselectivities (up to 87% ee).

Planar chiral chromium complexes are useful chiral auxiliaries and ligands for asymmetric synthesis. To the best of our knowledge, their preparation required a stoichiometric amount of chiral reagents and/or functionalization of starting compounds. The second part of the thesis is focused on an efficient alternative to planar-chiral complexes using a direct catalytic asymmetric C−H arylation of non-functionalized (fluoroarene)chromium complexes. Planar-chiral ligands from a family of (H_8)-BINAP derivatives and Buchwald's catalysts were prepared and tested in the C−H arylation of (fluorobenzene)tricarbonylchromium complex. The combination of XPhos-based Buchwald's catalyst and (H_8)-BINAP(O) ligand led to the most promising results affording a monoarylated product with high enantioselectivity (80% ee) in moderate yield (43%) and with a significantly decreased extent of undesired bisarylation.

Keywords

Organocatalysis, non-covalent catalysis, H-bonding donors, nucleophilic catalysis, bifunctional (thio)ureas, saccharides, aminophosphines, MBH reaction, [4+1] cyclization, asymmetric catalysis, C−H arylation, (η^6-arene)chromium complexes, planar chirality.