C-Heteroatom Bond Formation by Acid Catalysed Allylic Substitution of Trichloroacetimidate

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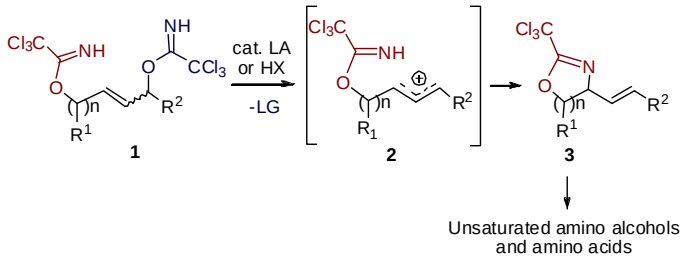
Nucleophilic allylic substitution is a widely used approach to C-heteroatom bond formation. This reaction type mostly relies on late transition metal catalysis [1]. However, in order to develop more economic and eco-friendly methods, Lewis and Brønsted acid catalysts have emerged as an alternative to late transition metal catalysed allylic substitution reactions.

We have found that bis-trichloroacetimidates **1** undergo efficient allylic substitution catalysed by Lewis or Brønsted acid. In this reaction, one of the imidate groups serves as *N*-nucleophile to form C–N bond and another imidate serves as a leaving group when activated by an acid catalyst (Scheme 1).

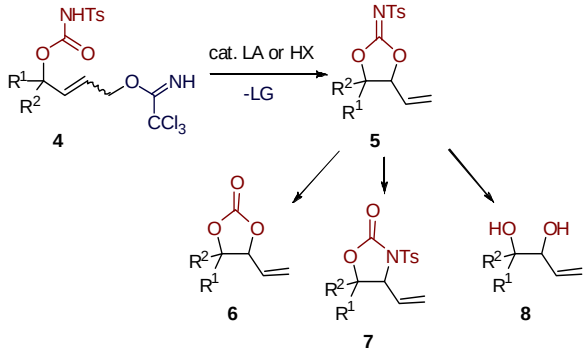


Scheme 1. Lewis or Brønsted acid catalysed cyclization of bis-trichloroacetimidates

Cyclization of substrate **1** (R^2=H) efficiently gave corresponding oxazolines **3** (n=1) and oxazines **3** (n=2) that are precursors of unsaturated amino alcohols and amino acids. We have proposed S_N1 mechanism for the cyclization of allylic bis-trichloroacetimidates **1**. This was based on the observation that C–N bond formation took place at the most substituted carbon atom (when R^1=Alk, Ar, R^2=H,) and that racemisation took place in the case of enantioenriched substrate **1**.

Cyclization of disubstituted allylic bis-imidates **1** (R≠H) gave disubstituted oxazolines **3** in excellent yields. We investigated reaction diastereo- and regioselectivity depending on the substrate structure, Lewis acid catalyst and the solvent. It was found that the configuration of a substrate **1** double bond determined the reaction diastereoselectivity. In the case of *E*-bis-imidates *cis*-oxazolines *cis*-**3** were obtained, while *Z*-bis-imidates gave *trans*-oxazolines *trans*-**3** as major products. Cyclization was highly regioselective in the case of substrates **1** which contained carbenium ion stabilizing group at allylic carbon (R = Ar).

To extend the scope of acid-catalysed allylic trichloroacetimidate substitution, we investigated *N*-tosylcarbamoyloxy group as a nucleophile. According to the literature, *N*-tosylcarbamoyloxy group can react either as *N*-[2] or *O*-nucleophile [3]. Exclusive *O*-allylation was observed by substitution of trichloroacetimidate in *N*-tosylcarbamates **4** providing *N*-tosyl iminocarbonates **5** (Scheme 2).



Scheme 2. Lewis or Brønsted acid catalysed cyclization of *N*-tosylcarbamates

Cyclization of *N*-tosylcarbamates **4** derived from secondary alcohols (R^1=Alk, Ar; R^2=H) preferentially gave *trans*-iminocarbonates **5** in d.r. up to 80:1. However, *trans* selectivity depended on the substitution pattern, substrate configuration and the catalyst. We also demonstrated that cyclization products **5** could be transformed to carbonates **6**, oxazolidinones **7** and 1,2-diols **8**.

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