**Gold-Catalyzed Cycloisomerization of α-Functionalized Allenes to \( N \)-Hydroxypyrrrolines, Dihydroisoxazoles and Dihydro-1,2-oxazines**

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**Introduction**

The gold-catalyzed *endo-* or *exo*-selective cycloisomerization of functionalized allenes is a highly valuable method for the synthesis of five- or six-membered oxygen-,[3,4] nitrogen-[12,13] or sulfur-containing[14] heterocycles containing one or several stereogenic centers. Since the gold-catalyzed cycloisomerization of allenenes is so far limited to the synthesis of heterocycles containing just one heteroatom, we decided to examine the cyclization of various allenyl hydroxylamines.[5] These investigations are particularly interesting due to the ambident nature of hydroxylamines which can result in the formation of different heterocycles.

**Results and Discussion**

**Cycloisomerization of Allenic Hydroxylamines to \( N \)-Hydroxypyrrrolines**

The cycloisomerization of allenic hydroxylamine 1a selectively led to the formation of \( N \)-hydroxypyrrroline 2a with full axis-to-center chirality transfer. The best result was obtained by using 1.5 mol% AuCl, whereas the cationic gold complexes \([\text{Ph}_3\text{PAuBF}_4]\), \(A^1\) or \(B^1\) led to incomplete conversion and/or decomposition.

**Cycloisomerization of Allenic Hydroxylamine Ether to Dihydro-1,2-oxazines or Dihydroisoxazoles**

By employing AuCl or AuCl\(_2\), the cycloisomerization of an allenyl hydroxylamine ether 3a resulted in a mixture of dihydrooxazine 4a and dihydroisoxazole 5a. Fortunately, the use of cationic complex \(A\) led nearly exclusively to the formation of dihydroisoxazoles 5a-5g.

The high diastereomeric excess in case of 5a-5c can be explained by coordination of precatalyst \(A\) to the allenic double bond adjacent to the heteroatoms. After 5-*endo*-cyclization the bulky gold moiety is preferably situated trans to the group \(R^3\) in order to minimize steric interactions.

**Cycloisomerization of Allenic Hydroxylamines to Dihydro-1,2-oxazines**

The selective formation of dihydro-1,2-oxazines 7a-7d was achieved by treating the carbamates 6a-d with AuCl. In contrast to the formation of dihydroisoxazoles 5, the use of cationic gold precatalysts led to decomposition of the substrates.

**Conclusion**

Three different chiral heterocycles are obtained by highly efficient regio- and stereoselective gold-catalyzed cycloisomerization of allenyl hydroxylamine derivatives. In all cases, nitrogen acts as the nucleophile and attacks the allene in a 5- or 6-*endo*-cyclization. Careful choice of the gold precatalyst and of the protecting group at the nitrogen are the key factors for controlling the regioselectivity.

**References**


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