Copper-Catalyzed Asymmetric Ring Opening of D–A Cyclopropanes

Significance: The authors report a copper-catalyzed enantioselective ring-opening reaction of donor–acceptor cyclopropanes with water. A variety of ring-opening products were obtained in high yields (≥96%) and enantioselectivities (≥95% ee).

Comment: In this reaction, the copper hydrate serves as both a Lewis acid and a source of water; this affords a system for the controlled release of the appropriate amount of water as a nucleophile in the asymmetric catalysis. The method provides a new and efficient approach for direct access to γ-substituted γ-hydroxybutyric acid derivatives.

Selected examples:

- \[ \text{CO}_2(2-\text{Ad}) \text{CO}_2(2-\text{Ad}) \]
  - R
  - \( R \text{CO}_2(2-\text{Ad}) \text{CO}_2(2-\text{Ad}) \)
  - MeO
  - 95% yield
  - 93% ee

- \[ \text{PhCO}_2(2-\text{Ad}) \text{CO}_2(2-\text{Ad}) \]
  - \( \text{Ph} \text{CO}_2(2-\text{Ad}) \text{CO}_2(2-\text{Ad}) \)
  - 95% yield
  - 87% ee

- \[ \text{OH} \text{CO}_2(2-\text{Ad}) \text{CO}_2(2-\text{Ad}) \]
  - MeO
  - 70% yield
  - 95% ee

- \[ \text{OH} \text{CO}_2(2-\text{Ad}) \text{CO}_2(2-\text{Ad}) \]
  - Ph
  - 91% yield
  - 82% ee

- \[ \text{OH} \text{CO}_2(2-\text{Ad}) \text{CO}_2(2-\text{Ad}) \]
  - BocN
  - 96% yield
  - 87% ee

Effect of the water loading:

- "excessive amount of water"
  - \( \text{H}_2\text{O} \) (5.0 equiv)
  - Cu(OTf)$_2$ (10 mol%)
  - DME, r.t.
  - \( \text{OH} \text{CO}_2(2-\text{Ad}) \text{CO}_2(2-\text{Ad}) \)
  - 91% yield, 66% ee

- "appropriate amount of water"
  - Cu(ClO$_4$)$_2$ 6H$_2$O (15 mol%)
  - DME, r.t.
  - \( \text{OH} \text{CO}_2(2-\text{Ad}) \text{CO}_2(2-\text{Ad}) \)
  - 91% yield, 92% ee

- "water free"
  - Cu(OTf)$_2$ (10 mol%)
  - DME, r.t.
  - \( \text{OH} \text{CO}_2(2-\text{Ad}) \text{CO}_2(2-\text{Ad}) \)
  - 34% yield, 90% ee

- "removal of water"
  - 4 Å MS
  - Cu(OTf)$_2$ (10 mol%)
  - DME, r.t.
  - \( \text{OH} \text{CO}_2(2-\text{Ad}) \text{CO}_2(2-\text{Ad}) \)
  - product not observed

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