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Aerobic Oxidation of Veratryl Alcohol to Veratraldehyde with Heterogeneous Ruthenium Catalysts

Lignin is a complex polymeric molecule constituting various linkages between aromatic moieties. Typically, the β-O-4 linkage accounts for more than half of the linkage structures present in lignin. The current study focuses on the oxidative transformation of veratryl alcohol (VA)—a compound that can be formed by cleavage of β-O-4 linkages in lignin—to veratraldehyde (VAld) with air using ruthenium supported on γ-alumina or silica as catalyst with water or methanol as solvent in a batch reactor. Ru/Al₂O₃, prepared with ruthenium(IV)oxide hydrate showed superior catalytic activity, yielding 89 % VAld in water at 160 °C with 5 bar air pressure after 8 h of reaction. Prolonged reaction time led to significant formation of the decarbonylated product veratrol from VAld. When the reaction was completed under 20 bars of argon in methanol instead of water, the methyl ether of VA (i.e. 1,2-dimethoxy-4-(methoxymethyl)benzene) prevailed, indicating that methanol protected the hydroxyl group in VA from being oxidized to VAld. Catalysts containing alternative transition metals (Mn, Co, Cu and Ag) supported on Al₂O₃ gave significantly lower activities compared to Ru/Al₂O₃ under identical reaction conditions. The Ru/Al₂O₃ catalyst was reused in three consecutive reaction runs in water, but a decrease in VAld yield was obtained after the third cycle possibly due to leaching of Ru from the support.

General information
State: Published
Organisations: Department of Chemistry, Centre for Catalysis and Sustainable Chemistry, Organic Chemistry
Contributors: Melián Rodriguez, M., Shunmugavel, S., Kegnæs, S., Riisager, A.
Number of pages: 7
Pages: 1036-1042
Publication date: Oct 2015
Peer-reviewed: Yes
Early online date: Sep 2015

Publication information
Journal: Topics in Catalysis
Volume: 58
Issue number: 14
ISSN (Print): 1022-5528
Ratings:
BFI (2018): BFI-level 1
Web of Science (2018): Indexed yes
BFI (2017): BFI-level 1
Scopus rating (2017): CiteScore 2.57 SJR 0.965 SNIP 0.753
Web of Science (2017): Impact factor 2.439
Web of Science (2017): Indexed yes
BFI (2016): BFI-level 1
Scopus rating (2016): CiteScore 2.55 SJR 0.975 SNIP 0.877
Web of Science (2016): Impact factor 2.486
Web of Science (2016): Indexed yes
BFI (2015): BFI-level 1
Scopus rating (2015): CiteScore 2.41 SJR 0.926 SNIP 0.777
Web of Science (2015): Impact factor 2.355
Web of Science (2015): Indexed yes
BFI (2014): BFI-level 1
Scopus rating (2014): CiteScore 2.29 SJR 0.987 SNIP 0.845
Web of Science (2014): Impact factor 2.365
Web of Science (2014): Indexed yes
BFI (2013): BFI-level 1
Scopus rating (2013): CiteScore 2.67 SJR 1.119 SNIP 0.827
Web of Science (2013): Impact factor 2.22
ISI indexed (2013): ISI indexed yes
Web of Science (2013): Indexed yes
BFI (2012): BFI-level 1
Scopus rating (2012): CiteScore 2.49 SJR 1.196 SNIP 0.848
Web of Science (2012): Impact factor 2.608
ISI indexed (2012): ISI indexed yes