Selective Hydrogenation of Renewable Raw Materials Using Commercial Catalyst Systems

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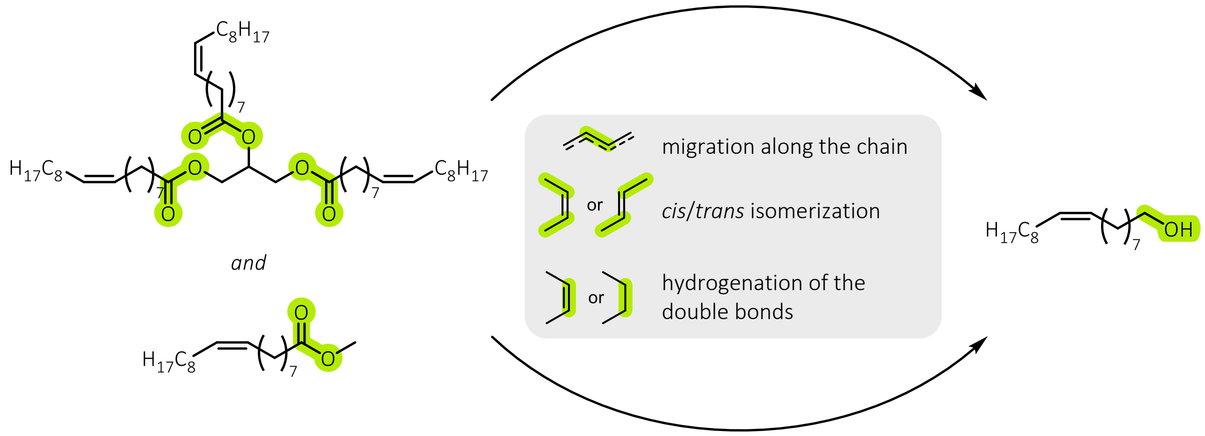
Abstract

The selective hydrogenation of fatty acid methyl esters to unsaturated fatty alcohols is a key process in the chemical industry. Unsaturated fatty alcohols are essential raw materials for the production of environmentally friendly surfactants, cosmetics and bio-based polymers. Selective hydrogenation of C=O bonds without hydrogenating, migrating, or isomerizing the C=C double bonds requires the employment of specifically designed catalyst systems.



Scheme 1. General reaction scheme and challenges of the catalytic hydrogenation of methyl oleate and trioleate with molecular hydrogen to oleyl alcohol.

The heterogeneously catalyzed hydrogenation of fatty acid methyl esters is a process that is carried out in industrial settings using zinc chromite catalysts under relatively harsh conditions. The comparatively low activity of such catalysts requires temperatures from 200 to 300 °C and hydrogen pressures of up to 300 bar. The scientific literature offers only a limited description of homogenous transition metal complexes that can be used for the selective hydrogenation of methyl oleate to oleyl alcohol. These catalyst systems are predominantly based on transition metals such as manganese and ruthenium, while osmium complexes are rarely considered. A significant disadvantage of these systems is that the complexes are often not commercially available, and their synthesis is time-consuming and resource-intensive.

Given that commercially available oleyl alcohol exhibits an industrial purity level of only 50–85%, the objective of our investigations was to identify a homogeneous catalytic approach with commercially available catalysts that would yield a final product purity level exceeding 90%, employing HOSOME (high-oleic sunflower oil methyl ester) as the initial substrate.