Glucose Isomerization by Enzymes and Chemo-catalysts: Status and Current Advances

The well-known interconversion of aldoses to their corresponding ketoses was discovered more than a century ago, but has recently attracted renewed attention due to alternative application areas. Since the pioneering discovery, much work has been directed toward improving the process of isomerization of aldoses in terms of yields, catalysts, solvents, catalytic systems, etc., by both enzymatic and chemo-catalytic approaches. Among aldose ketose interconversion reactions, fructose production by glucose isomerization to make high-fructose corn syrup (HFCS) is an industrially important and large biocatalytic process today, and a large number of studies have been reported on the process development. In parallel, also alternative chemo-catalytic systems have emerged, as enzymatic conversion has drawbacks, though they are typically more selective and produce fructose under mild reaction conditions. Isomerization of glucose is also a central reaction for making renewable platform chemicals, such as lactic acid, 5-hydroxymethylfurfural (HMF), and levulinic acid. In these other applications, thermally stable catalysts are required, thus making use of enzymatic catalysis inadequate, since enzymes generally possess a limited temperature operating window, typically less than 80 ºC. From this viewpoint, the chemo-catalysts especially solid heterogeneous catalysts are playing a key role for the development of not only making HFCS, but also making chemicals and fuels from glucose via the isomerized product/intermediate fructose. This review focuses on how both enzyme and chemo-catalysts are being useful for the isomerization of glucose to fructose. Specifically, development of Lewis acid containing zeolites for glucose isomerization is reviewed in detail, including mechanism, isotopic labeling, and computational studies.

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