A novel D-xylose isomerase: from the gut of a wood feeding beetle for improved conversion in *Saccharomyces cerevisiae*

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Carbohydrate rich substrates such as lignocellulosic hydrolysates remain one of the primary sources of potentially renewable fuel and bulk chemicals. The pentose sugar D-xylose is often present in significant amounts along with hexoses. For low value/high volume products, yield is of paramount importance for process economy. Saccharomyces cerevisiae can acquire the ability to metabolize D-xylose through expression of heterologous D-xylose isomerase (XI). This enzyme is notoriously difficult to express in S. cerevisiae and only fourteen genes have been reported to be active so far. We cloned a new D-xylose isomerase derived from microorganisms in the gut of the wood-feeding beetle Odontotaenius disjunctus. Although somewhat homologous to the current gold-standard from Piromyces sp. E2, metagenome scaffold gene neighborhoods and metagenome binning identified the gene as of bacterial in origin and the host as a Parabacteroides sp. Expression of the new XI enzyme in S. cerevisiae resulted in faster aerobic growth on D-xylose than the XI from Piromyces. The D-xylose isomerization rate of the yeast expressing this new XI was also 72 % higher. Interestingly, increasing concentrations of xylitol (up to 8 g/L) appeared not to inhibit xylose consumption in both strains. The newly described XI displayed 2.6 times higher specific activity, 37 % higher affinity for D-xylose, and exhibited higher activity over a broader temperature range, retaining 51 % of maximal activity at 30 °C compared with only 29% activity for the Piromyces XI. This new enzyme represents a highly valuable addition to the S. cerevisiae molecular toolbox and shows promise for improved industrial conversion of carbohydrates.

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