

Microbial Pentose Metabolism

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Introduction

Speakers were asked to provide quantitative data on the performance of different xylose- (or, in one instance, arabinose-) fermenting strains in laboratory media and, where possible, in “industrial” media prepared by hydrolysis of native lignocellulosic substrates. The data provided are presented in Table 1, which gives an indication of the performance of the various strains but should not be taken as a rigorous comparison. In particular, there is considerable variation in the extent of nutritional supplementation of the various media and the degree of detoxification of the hydrolysates. References provided by some of the speakers are also given (1–6).

Speakers

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T. W. Jeffries, USDA Forest Products Laboratory, Madison, WI
R. Benson, Tembec Chemical Products, Temiscaming, Quebec, Canada
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A. Nilsson, University of Lund, Lund, Sweden
S. Helle, University of British Columbia, Vancouver, Canada

References

1. Becker, J. and Boles, E. (2003), *Appl. Environ. Microbiol.* **69**, 4144–4150.
2. Nigam, J. N. (2001), *J. Ind. Microbiol. Biotechnol.* **26**, 145–150.
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Table 1

Performance of Some Recombinant and Native Xylose-Fermenting Organisms Under Laboratory Conditions and on Native Lignocellulosic Hydrolysates

Strain	Laboratory conditions ^a			"Industrial" conditions ^b	
	Xylose concentration (g/L)	Ethanol yield (g/g) ^c	Ethanol productivity (g/[g cells·h]) ^d	Ethanol yield (g/g) ^c	Ethanol productivity (g/[g cells·h]) ^d
<i>Thermoanaerobacter thermosaccharolyticum</i> ^e	72 ^m	0.33 ^m	0.4 ^m	—	—
<i>Escherichia coli</i> KO11 ^f	90	0.47	0.38	0.49 ^q	0.37 ^q
<i>E. coli</i> FBR5 ^g	40	0.43	0.29	0.46 ^r	0.214 ^r
<i>Zymomonas mobilis</i> 8b ^h	100	0.47	1.13 ^p	0.42 ^s	—
<i>Pichia stipitis</i> CBS 6054 ⁱ	80	0.40	0.347	—	—
<i>P. stipitis</i> FPL-Shi21 ⁱ	80	0.46	0.43	—	—
<i>P. stipitis</i> NRRL Y-7124 ⁱ	—	—	—	0.41 ^t	0.44 ^t
<i>P. stipitis</i> CBS 5773 ⁱ	—	—	—	0.35 ^u	0.05 ^u
<i>Saccharomyces cerevisiae</i> JBY25-4M ^k	20 ⁿ	0.3 ⁿ	0.08 ⁿ	0.44 ^v	0.083 ^v
<i>S. cerevisiae</i> TMB 3006 ^l	—	—	—	—	—
<i>S. cerevisiae</i> TMB 3400 ^l	20	0.25 ^o	0.10 ^o	0.37 ^{w,x}	0.66 ^{w,x}
				0.43 ^{w,x}	0.25 ^{w,x}

^a Synthetic medium containing xylose or arabinose and one or more complex ingredients (unless otherwise indicated).

^b Mixed sugar hydrolysate of native lignocellulosic substrate lacking complex medium ingredients. Detoxification applied unless otherwise indicated.

^c Based on initial sugar concentration.

^d Based on time to produce 95% of final ethanol concentration.

^e Data supplied by L.R. Lynd.

^f Data supplied by S. Underwood.

^g Data supplied by B. S. Dien.

^h Data supplied by M. Zhang.

ⁱ Data supplied by T. W. Jeffries.

^j Data supplied by R. Benson.

^k Data supplied by J. Becker and E. Boles; arabinose fermenting strain.

^l Data supplied by A. Nilsson.

^m Chemostat data on 72 g/L xylose feed

ⁿ Carbon source: arabinose.

^o Defined mineral medium (no complex ingredients).

^p High specific productivity in part reflects low inoculum size.

^q Bagasse hemicellulose hydrolysate, mainly xylose (100 g/L of total sugars).

^r Supplemented with 2.5% (w/v) corn steep liquor.

^s Corn stover hydrolysate (37 g/L of xylose, 28 g/L of glucose, 20 g/L of arabinose).

^t Eighty percent overlimed corn stover hydrolysate (50 g/L of xylose, 75 g/L of glucose).

^u Data of Nigam, 2001, for fermentations on spent sulfite liquor.

^v Industrial scale continuous fermentations on rotoevaporated spent sulfite liquor (hardwood pulping, γ softwood pulping).

^w Industrial scale continuous fermentations on rotoevaporated spent sulfite liquor (softwood pulping).

^x Undetoxified hydrolysate.

^y Dilute acid hydrolysate of forest residuals, mainly spruce (6 g/L of xylose, 13 g/L of mannose, 16 g/L of glucose, 3 g/L of galactose, 1 g/L of arabinose), fed-batch fermentation.

4. Shi, N. Q., Davis B., Sherman F., Cruz J. and Jeffries T. W. (1999), *Yeast* **15**, 1021–1030.
5. Underwood, S. A., Zhou, S., Causey, T. B., Yomano, L. P., Shanmugam, K. T., and Ingram, L. O. (2002), *Appl. Environ. Microbiol.* **68**, 6263–6272.
6. Wahlbom, C. F., van Zyl, W. H., Jonsson, L. J., Hahn-Hagerdal, B., and Otero, R. R. C. (2003) *FEMS Yeast Res.* **3**, 319–326.