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Production of Lactic Acid from Xylose by *Rhizopus oryzae*

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The production of the biodegradable polymer Poly Lactic Acid (PLA) requires preferably optically pure L(+)-lactic acid monomers. The filamentous fungus *Rhizopus oryzae* is able to grow with the hexose glucose as sole carbon source and to produce L(+)-lactic acid [1],[2]. Less is known about the conversion by *R. oryzae* of the pentose sugar xylose, which is abundantly present in lignocellulosic materials and forms an important potential feedstock for microbial processes. Conversion of both hexose and pentose monosaccharides by *R. oryzae* results in higher yield of lactic acid per mole of total amount of available sugars.

Objective

Study the ability of the filamentous fungus *R. oryzae* to convert the pentose sugar xylose into lactic acid.

Results

- *R. oryzae* strains convert the pentose xylose mainly into lactic acid with yield of 0.38 - 0.72 g/g

- The production of the intermediate xylitol suggests that *R. oryzae* converts xylose through a two-step reduction and oxidation route

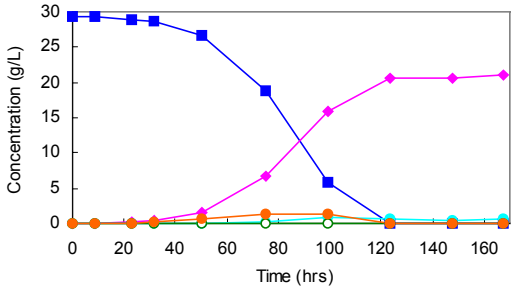

Fig 1. Typical conversion of xylose by R. oryzae *CBS 147.22,* (■) *xylose,* (◆) *lactic acid,* (○) *ethanol,* (●) *glycerol,* (●) *xylitol. Fungal biomass production was 1.3 g.L^{-1}. Experiments were performed in baffled flasks and were aerobically agitated at 37°C. $CaCO_3$ was used to neutralize the produced lactic acid and maintain pH. Substrates and products were determined by HPLC analysis.*

- Diauxic growth of *R. oryzae* occurs in media with glucose and xylose where glucose is utilised faster than xylose

- In mild-temperature alkaline treated wheat straw hydrolysate, xylose is converted by *R. oryzae* into lactic acid. Glucose is converted into both lactic acid and ethanol, which is likely caused by a low oxygen transfer rate in the hydrolysate.

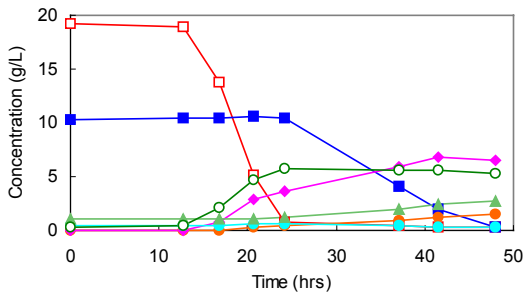

Fig 2. Conversion of sugars present in wheat straw hydrolysate by R. oryzae *CBS 112.07,* (■) *xylose,* (□) *glucose,* (◆) *lactic acid,* (○) *ethanol,* (●) *glycerol,* (●) *xylitol,* (▲) *acetic acid. Hydrolysate was obtained by mechanical treatment followed by mild-temperature alkaline treatment and enzymatic hydrolysis. Experiment performed as described in Fig. 1.*

Conclusions

R. oryzae converts the pentose xylose mainly into lactic acid. *R. oryzae* is able to convert both glucose and xylose in mild-temperature alkaline treated wheat straw hydrolysates.

References

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[2] Longacre A., J.M. Reimers, J.E. Gannon and B.E. Wright, Flux Analysis of Glucose Metabolism in *Rhizopus oryzae* for the Purpose of Increasing Lactate Yield, Fungal Genetics and Biology 21, 30-39 (1997)

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