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Reducing sugars facilitated carbonyl condensation in detoxification of carbonyl aldehyde model compounds for bioethanol fermentation

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We investigated the inhibitory effects of ortho-phthalaldehyde (OPA) as a carbonyl aldehyde model compound on fermentation and growth of *Saccharomyces cerevisiae* and its alkaline detoxification. OPA was a potent inhibitor on fermentation and growth of *S. cerevisiae* compared to vanillin, furfural and hydroxymethyl furfural (HMF) at the same concentration level. The inhibition of OPA on fermentation and growth of *S. cerevisiae* was dose dependent. Ethanol production and growth of *S. cerevisiae* were both completely inhibited in the presence of 1.0 mM OPA. The inhibition on fermentation and growth of the yeast decreased with the decrease of the OPA concentration between 0.02 mM-1.0 mM. OPA at 0.02 mM showed no inhibition on both fermentation and growth of yeast, the ethanol final yield was even increased by 4.6% compared to the control. The inhibition of OPA at low concentration could be overcome by increasing inoculation size of yeast. Most interestingly, we found OPA inhibition could be detoxified under alkaline condition (pH~10) at 60 °C for 2 h in the presence of a reducing sugar (ketone or aldose), but not non-reducing sugar. Mass spectral analysis of OPA reaction products in negative ion mode revealed a high intensity mass at 313.09 m/z ([M-H]-). This molecule (314) was predicted to be the aldol reaction product of reducing sugar and OPA under alkaline condition. One of the CHO groups on OPA was converted into hydroxyl group by nucleophilic addition of enolate ion of reducing sugar. Loss of one CHO group of OPA could be the key factor for the removal of OPA inhibition.

Biography

Maobing Tu is assistant professor at Auburn University, working on biomass and bioenergy. He completed his Ph.D. degree at University British Columbia and did postdoctoral studies at Pulp and Paper Research Institute of Canada.

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