Modeling of growth and laccase production by *Pycnoporus sanguineus*

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Abstract Production of extracellular laccase by the white-rot fungus *Pycnoporus sanguineus* was examined in batch submerged cultures in shake flasks, baffled shake flasks and a stirred tank bioreactor. The biomass growth in the various culture systems closely followed a logistic growth model. The production of laccase followed a Luedeking-Piret model. A modified Luedeking-Piret model incorporating logistic growth effectively described the consumption of glucose. Biomass productivity, enzyme productivity and substrate consumption were enhanced in baffled shake flasks relative to the cases for the conventional shake flasks. This was associated with improved oxygen transfer in the presence of the baffles. The best results were obtained in the stirred tank bioreactor. At 28 °C, pH 4.5, an agitation speed of 600 rpm and a dissolved oxygen concentration of ~25 % of air saturation, the laccase productivity in the bioreactor exceeded 19 U L⁻¹ days⁻¹, or 1.5-fold better than the best case for the baffled shake flask. The final concentration of the enzyme was about 325 U L⁻¹.

Keywords Laccase - *Pycnoporus sanguineus* - Kinetic modeling - Stirred tank bioreactor

List of symbols
dP/dt Rate of laccase production (U L⁻¹ days⁻¹)
dS/dt Rate of glucose consumption (g L⁻¹ days⁻¹)
x/dt Rate of biomass production (g L⁻¹ days⁻¹)
mₚ Cell maintenance coefficient (g g⁻¹ days⁻¹)
P Laccase activity (U L⁻¹)
Pᵣ Final laccase concentration (U L⁻¹)
P₀ Initial laccase concentration (U L⁻¹)
p Probability level
rₚ Volumetric productivity of laccase (U L⁻¹ days⁻¹)
rₓ Volumetric productivity of biomass (g L⁻¹ days⁻¹)
S Glucose concentration (g L⁻¹)
Sᵣ Final glucose concentration (g L⁻¹)
S₀ Initial glucose concentration (g L⁻¹)
t Time (days)
tᵣ Time at the end of the fermentation (days)
t₀ Time at the beginning of the fermentation (days)
Vᵣ Final fermentation volume (L)
V₀ Initial fermentation volume (L)
X Biomass concentration (g L⁻¹)
Xᵣ Measured final biomass concentration (g L⁻¹)
Xₘₐₓ Model predicted maximum biomass concentration (g L⁻¹)
X₀ Initial biomass concentration (g L⁻¹)
Yᵣ Model predicted biomass yield coefficient on glucose (g g⁻¹)
Yₓₓ Yield factor of biomass on substrate (g g⁻¹)
Yᵣₛ Yield factor of laccase on substrate (U g⁻¹)
Yᵣₓ Yield factor of laccase on biomass (U g⁻¹)

Greek letters
α Growth related constant (U g⁻¹)
β Non-growth related constant (U g⁻¹ days⁻¹)
μₘₐₓ Maximum specific growth rate (days⁻¹)