KINETIC CHARACTERIZATION AND DEVELOPMENT OF A SERIES OF CONTINUOUS REACTORS FOR BIOMASS HYDROLYSIS WITH COMMERCIAL CELLULASE COCKTAIL

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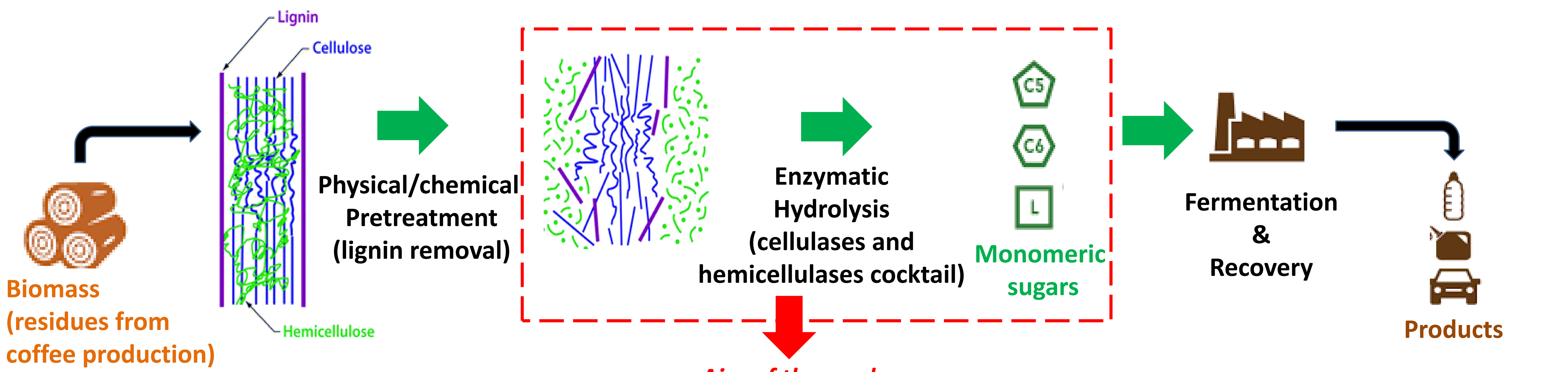
Background: biorefinery of lignocellulosic wastes



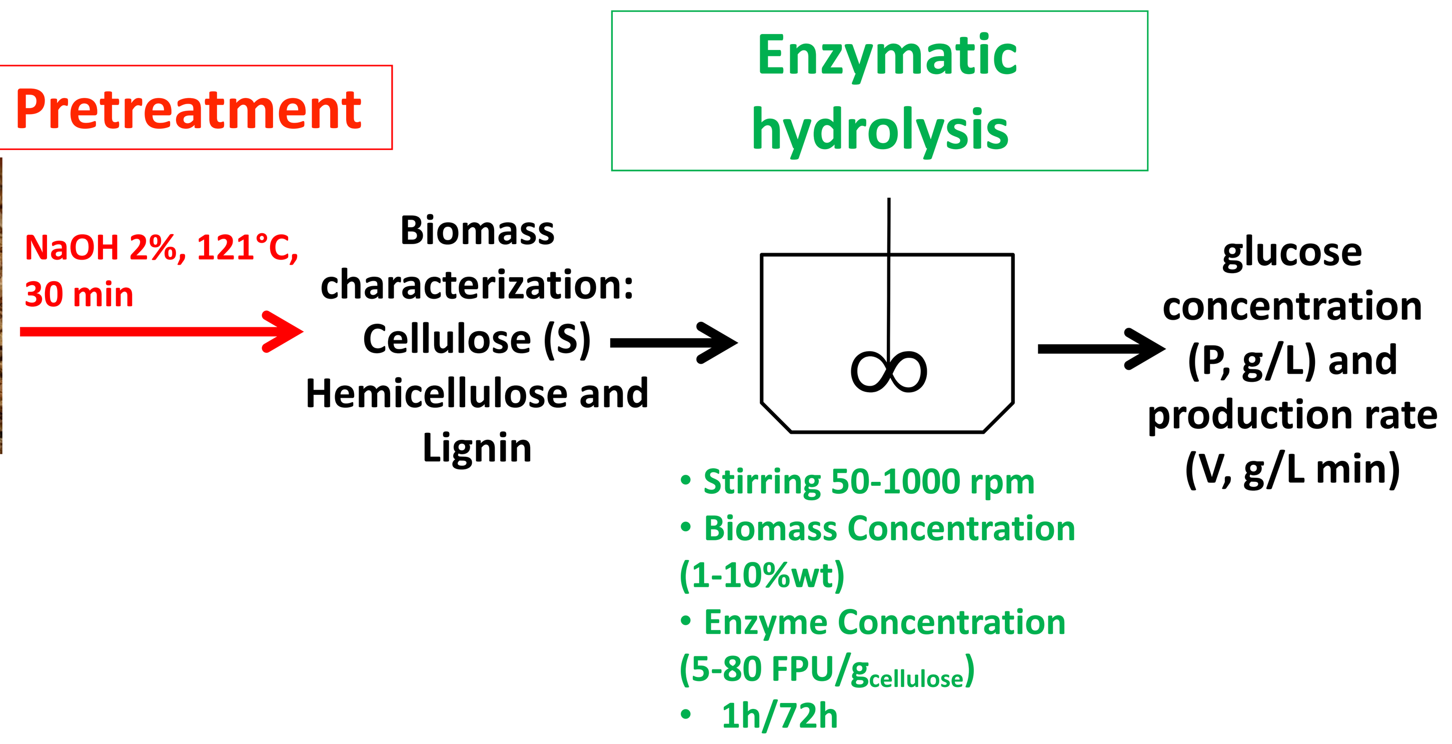
Aim of the work

Kinetic characterization of the commercial cellulases cocktail Cellic CTec2 (Novozymes) has been carried out in order to identify the best operating condition in term of mixing rate, substrate and enzyme concentration for the enzymatic hydrolysis of coffee silverskin.

Materials and Methods

Coffee silverskin was pretreated with NaOH[1] in order to remove lignin. Enzymatic hydrolysis at different operating conditions was carried out in an **overhead stirred batch reactor according to Pratto *et al.*[2]**. Samples were collected after 1h and until 72h and glucose concentration in the hydrolysate was measured[2]. The **glucose production rate** was calculated and the data were regressed through the Micheális-Menten, the Modified Michaelis-Menten and the Chrastil's models[2] .

Coffee silverskin



Data analysis and modeling

Michaelis-Menten with product inhibition

$$V = \frac{V_{max} \cdot S}{K_m\left(1 + \frac{P}{k_{ic}}\right) + S}$$

Modified Michaelis-Menten

$$V = \frac{V_{emax} \cdot E_0}{K_e\left(1 + \frac{P}{k_{ic}}\right) + E_0}$$

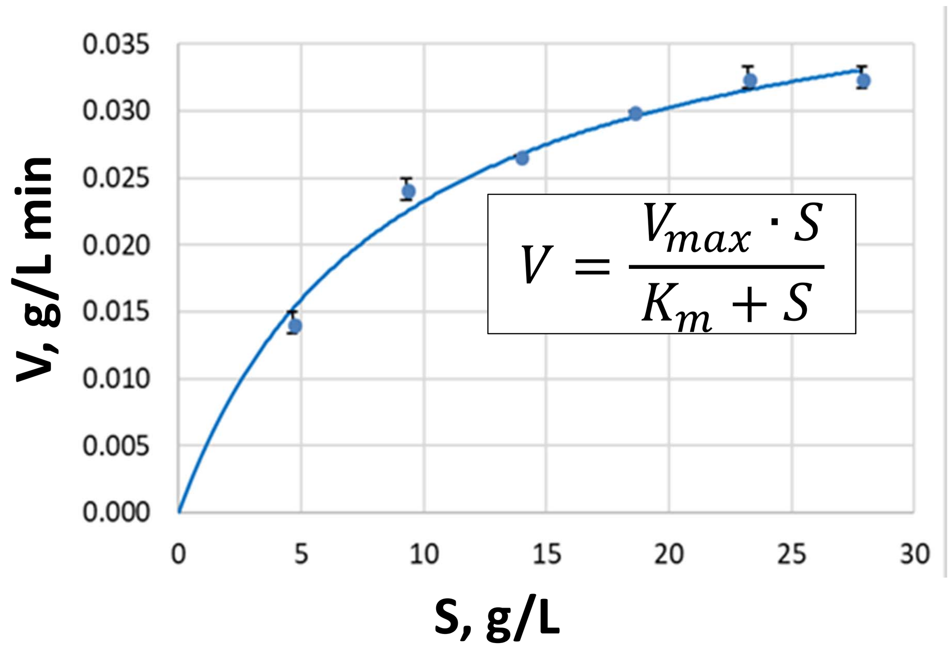
Chrastil's model

$$P = P_\infty \cdot [1 - exp(-k'E_0 t)]^n$$

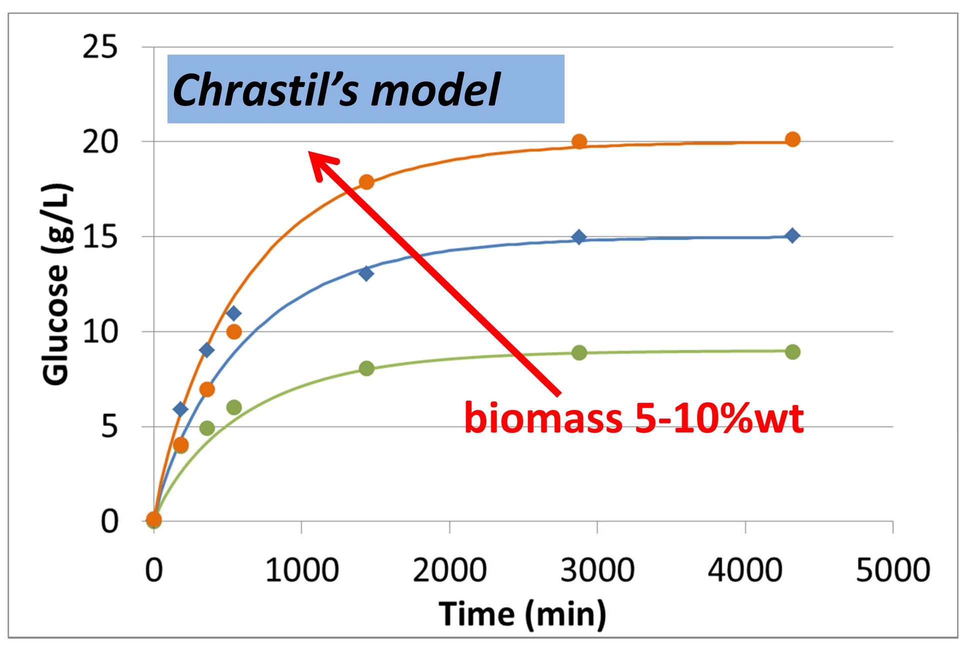
Results

Kinetic parameters have been reported in the **Table 1**.

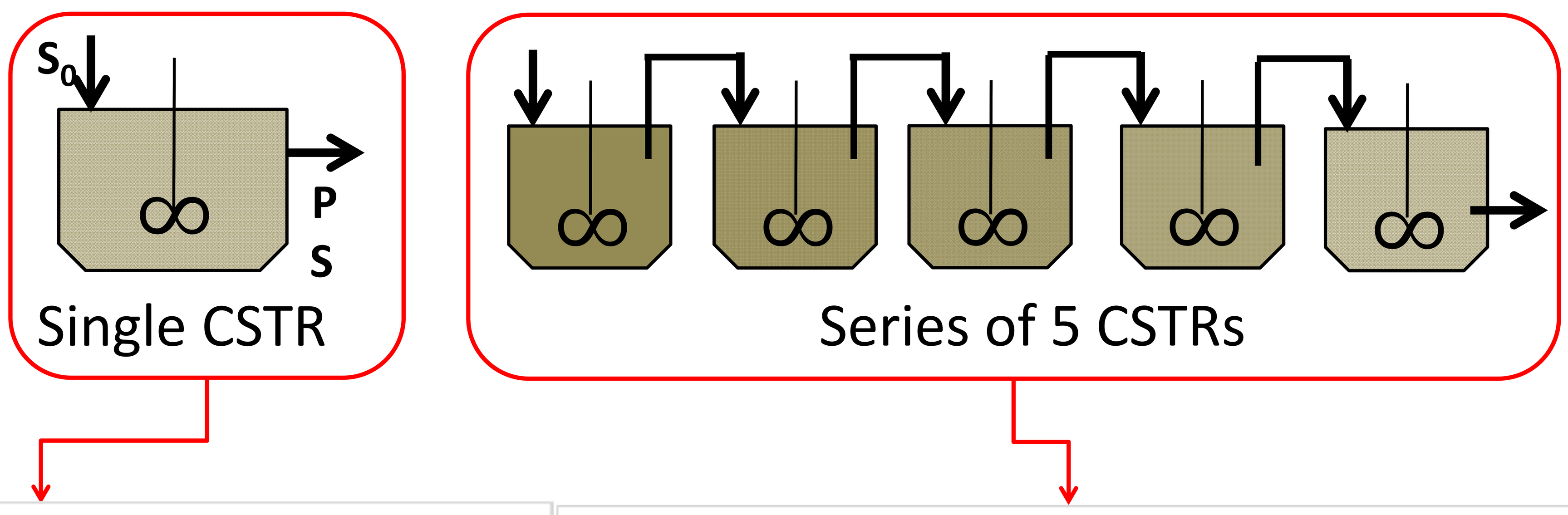
Effect of biomass concentration on initial rate (1h)

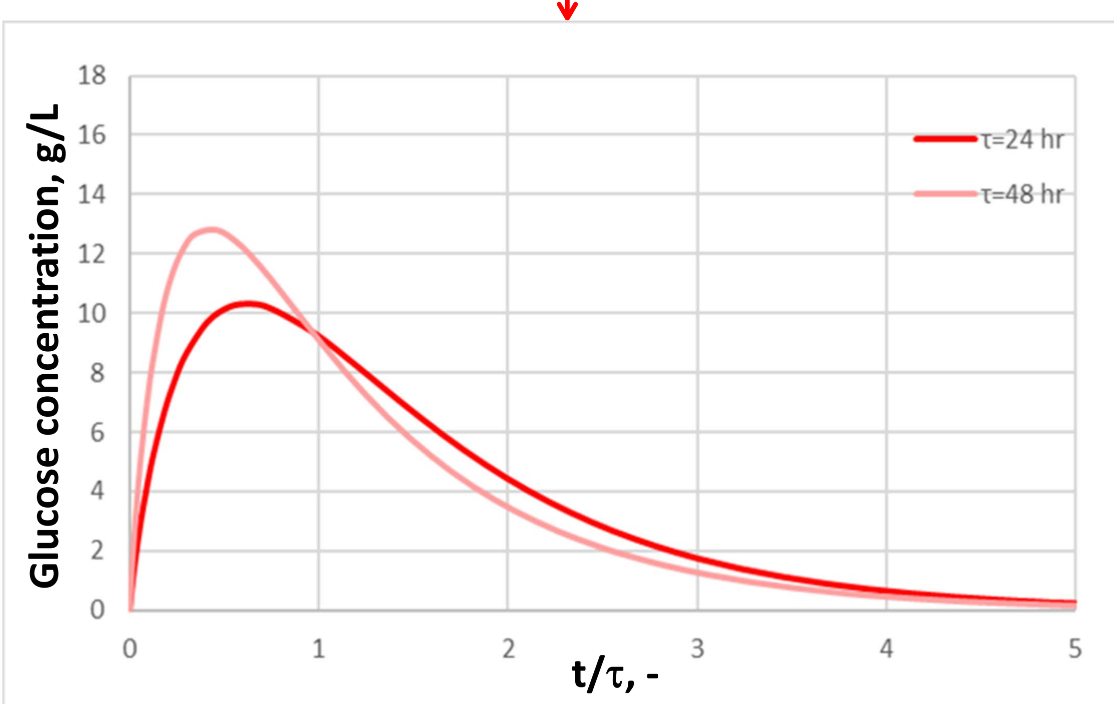


Effect of glucose inhibition on long term hydrolysis (72h)



Theoretical model of continuous reactors for the hydrolysis of coffee silverskin was developed including the best fitting kinetic model into mass balances on glucose. The perfomances of a single CSTR and of a series of 5 CSTRs have been simulated in terms of glucose concentration time course in the liquid phase.





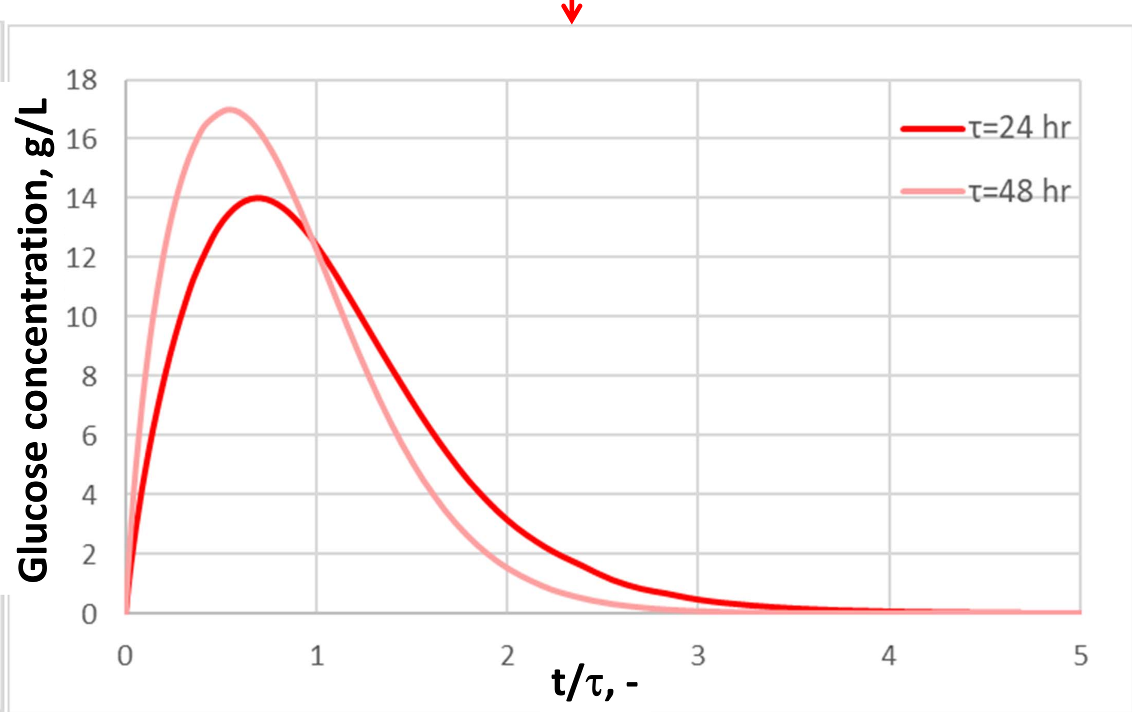


Table 1

Biomass	Glucan (%wt)	Lignin (%wt)	Biomass recovery %	Ps. Hom. Michaelis-Menten			Modified Michaelis-Menten			Chrastil's model	
				V_{max} ($g\,L^{-1}\,min^{-1}$)	K_M ($g\,L^{-1}$)	k_{ic} ($g\,L^{-1}$)	V_{emax} ($g\,L^{-1}\,min^{-1}$)	K_e ($g\,L^{-1}$)	k_{ic} ($g\,L^{-1}$)	k' ($L\,g^{-1}\,min^{-1}$)	n, -
Raw	17.5	29.9	100	-	-	-	-	-	-	-	-
Alkali pretreated	23.2	18.4	72	0.043 ± 0.002	8.6 ± 1.6	8±2	0.156 ± 0.002	4.5 ± 0.2	0.7 ± 0.1	(1.2 ± 0.1) 10-4	0.85 ± 0.04

Acknowledgements

Alessio Occhicone is gratefully acknowledged for performing experimental tests and theoretical simulations.

References

[1] Procentese et al., 2017 Biomass. Bioener.; 96: 172-179.

[2] Pratto et al., 2016 Appl. Biochem. Biotechnol.; 178: 1430-144.

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 654623

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