Innovative biorefinery process for the fractionation and conversion of giant reed to carotenoids and triglycerides

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In the last decades the increase in the use of fossil resources contributed to several environmental issues. The replacement of traditional refineries with innovative biorefinery is necessary to reduce the impact of human activities [1]. Biorefinery processes convert low or negative value biomasses into energy, materials and bioproducts. Lignocellulosic biomasses, such as giant reed, are renewable feedstock that does not interfere with food industry, mainly composed of lignin, cellulose and hemicellulose. The last two fractions are biopolymers that can be used as starting material for the production of fermentable sugars or other platform chemicals by chemical and/or biological catalytic approaches. *Rhodosporidium toruloides* is an oleaginous yeast able to convert sugars into carotenoids and triglycerides [2]. Carotenoids are high added-value molecules employed in different fields, such as food industry, human health and semiconductors [3]. Triglycerides are platform chemicals that can find applications in several industry sectors related to human health, nutraceutical, biosurfactant and biopolymers. From an industrial point of view production, microbial triglycerides and carotenoids are a sustainable alternative respect to vegetable oil or carotenoids extracted from plants and/or food. In this context, the aim of this work is to design, develop and optimise an innovative multi-step process for the fractionation of giant reed and conversion of its holocellulose fraction to carotenoids and triglycerides, according to the following steps: i) hydrothermal pretreatment of giant reed in the presence of dilute imidazole for removing lignin; ii) enzymatic hydrolysis of the polysaccharides-rich pretreated solid to glucose and xylose by the industrial enzymatic mix Cellic® CTech 3; iii) fermentation of hydrolysates to carotenoids and lipids. Pretreatment is affected by several parameters (concentration of imidazole, temperature, reaction time, solid to liquid ratio) which were optimised in the present work. Under the optimised reaction conditions for pretreatment and hydrolysis, about 60 wt% of lignin removal was achieved, together with glucose and xylose yields of 99 and 82 mol%, respectively. Also the fermentation process with *Rhodosporidium toruloides* was optimised both adopting synthetic media and raw biomass hydrolysates, investigating the effect of C/N ratio, inoculum size, nutrients composition and process kinetics. Under the optimised process conditions, the carotenoids and lipids productions were 103 mg/L and 1.1 g/L, respectively, a promising value for next studies.

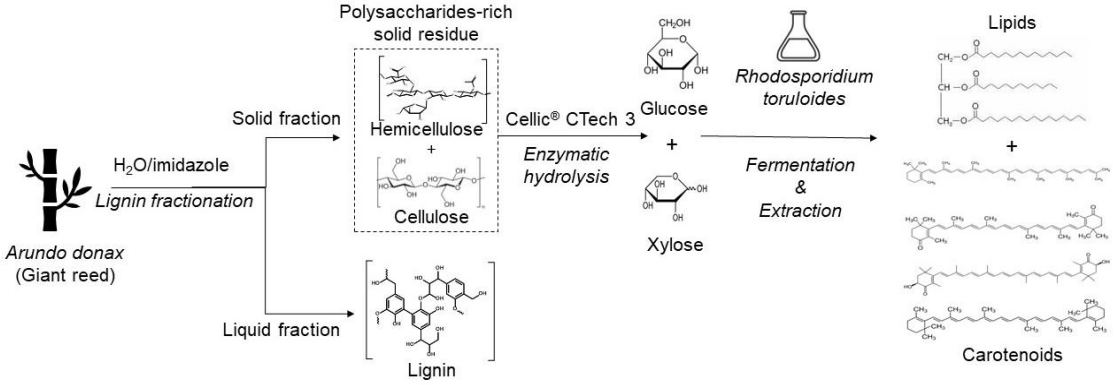

Figure 1. Process layout of the innovative biorefinery process developed in the present study.

References:

[1] N. Di Fidio, F. Minonne, C. Antonetti, A. M. Raspolli Galletti, Catalysts, 11, 1291 (2021)
[2] *X. Zhao, C. Hu, S. Wu, H. Shen, Z. K. Zhao,* J. Ind. Microbiol. Biotechnol. 38, 627 (2011)
[3] V. Ashokkumar, G. Flora, M. Sevanan, R. Sripriya, W.H. Chen, J. Park, J. Rajesh, G. Kumar, Bioresour. Technol. 367 (2023)