Microwave-assisted $FeCl_3$-catalysed production of glucose from giant reed and cardoon cellulose fraction and its fermentation to new generation oil by oleaginous yeasts

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The replacement of fossil fuels and materials with biofuels and bioproducts is a crucial current global goal. Biorefining of lignocellulosic biomass generates pentose and hexose sugars which can be converted into several added-value bio-based compounds. Among biofuels, biodiesel is one of the most promising renewable energy sources since it does not require new technology and engines for its use. Traditional biodiesel is produced on the industrial scale starting from vegetable oils obtained from oleaginous crops, such as palm oil, rapeseed oil and sunflower oil. However, most of the oleaginous plant species are food crops, determining the ethical debate on the right use of these renewable resources and the competition between the energy industry and food chain. An innovative and promising solution is represented by single cell oil (SCO) produced from oleaginous yeasts. This new generation oil, if obtained from low or negative value industrial waste, represents a promising platform chemical for the production of biodiesel, biosurfactants, animal feed and biobased plastics [1]. This study investigated the microwave-assisted $FeCl_3$-catalysed hydrolysis of giant reed (*Arundo donax* L.) and defatted cardoon (*Cynara cardunculus* L.) cellulose fractions to give glucose. Giant reed is a promising energy crops able to grow on marginal lands, while cardoon stalks are the crop residue in the production of vegetable oil. A preliminary acid pretreatment was adopted for giant reed [2], while steam-explosion pretreatment was performed on cardoon [3], both allowing a significant removal of xylan fractions. Under different reactions conditions, the microwave-assisted $FeCl_3$-catalysed hydrolysis converted the two pretreated feedstocks into glucose-rich hydrolysates which were employed as fermentation medium for the production of SCO by the oleaginous yeast *Lipomyces starkeyi* DSM 70296. For giant reed, the low production of furanic compounds enabled the direct fermentation of undetoxified hydrolysates, while for cardoon the furfural removal was necessary before the fermentation step. After hydrolysis, for both hydrolysates the fermentation provided promising lipid yields (~14 wt%) and oil content (~25 wt%). Figure 1 shows the process layout of the implemented third-generation biorefinery scheme. The SCO appears a valid candidate for the production of new generation biodiesel with good oxidative stability and cold flow properties. Moreover, it resulted very similar to palm and rapeseed oils, usually employed as a renewable source for the production of traditional biodiesel.

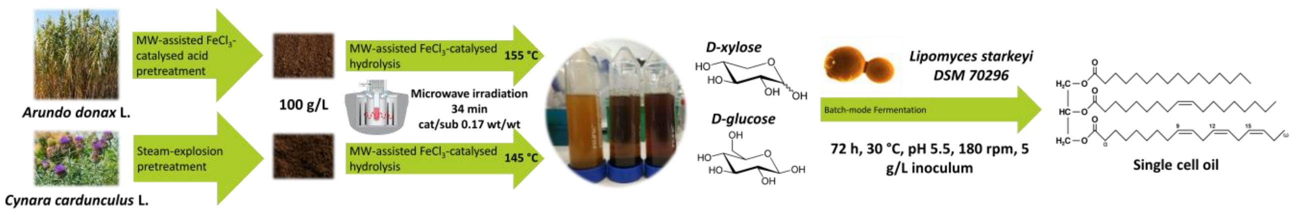

Figure 1. Schematic representation of the implemented biorefinery scheme.

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[2] N. Di Fidio, S. Fulignati, I. De Bari, C. Antonetti, A.M. Raspolli Galletti, *Bioresour. Technol.* **2020**, *313*, 123650.
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