X Workshop Gruppo Interdivisionale Green Chemistry – Chimica Sostenibile

1a Giornata Congiunta con la Divisione di Chimica Industriale

Firenze – 6 Ottobre 2023

Chemical and biological catalysis for the green production of valuable carotenoids and triglycerides from waste wheat bran

[1] Nicola Di Fidio, [2] Getari Kasmiarti,[1] Leonardo Carmassi, [1] Domenico Licursi, [1] Sara Fulignati, [1] Claudia Antonetti, [1] Anna Maria Raspolli Galletti

[1] Department of Chemistry and Industrial Chemistry, University of Pisa, Via G. Moruzzi 13, Pisa, Italy
[2] Universitas Sriwijaya, Jalan Padang Selasa No.524, Palembang 30139, South Sumatra, Indonesia
(nicola.difidio@unipi.it)

Defatted wheat bran, an industrial waste of the food chain, represents a strategic renewable material for modern biorefinery schemes, due to its low cost and chemical composition. Based on the synergistic combination of chemical and biological green catalysis, an innovative cascade process was designed and optimised to produce added-value fine chemicals represented by carotenoids and lipids. For defatted wheat bran, no pretreatment step was necessary due to its very low content of lignin, about 2 wt%, and suitable particle size deriving from its industrial mechanical processing. Thus, the direct enzymatic hydrolysis of its carbohydrate fractions was performed and optimised using the commercial biocatalyst Cellic CTec 3 HS. The effect of different biomass loadings (2, 10, 15 and 20 wt%) and enzyme dosages (15, 30, 45, 60 FPU/g glucan) on the sugars (glucose, xylose, arabinose) yield was investigated and optimised. At the same time, a microwave-assisted $FeCl_3$-catalysed approach was studied and optimised for the selective conversion of polysaccharides to fermentable sugars. Also in this case, catalyst amount, reaction time, temperature and biomass loading were optimised to maximise sugars concentration and minimise the synthesis of furanic derivatives (furfural, 5-HMF) which hamper the subsequent fermentation step. At this regard, for the biological simultaneous conversion of sugars to carotenoids and lipids, the safe commercial yeast *Rhodosporidium toruloides* DSM 4444 was employed as the catalyst. Carotenoids present several commercial applications in food, pharmaceutical, nutraceutical and cosmetic industries and in the field of innovative materials for electronics, such as transistors. Similarly, triglycerides are an essential industrial platform chemical to produce biofuels (e.g., biodiesel), animal feed, bioplastics, biosurfactants, additives and lubricants. The fermentation process was optimised in terms of culture medium, carbon source and C/N ratio. Finally, the two main bio-products were extracted, characterised and quantified. Under the optimised reaction conditions, *Rhodosporidium toruloides* converted all the sugars of the lignocellulosic hydrolysate into carotenoids and lipids, achieving production values of about 180 mg/L and 3.0 g/L, respectively. The single-cell oil profile was similar to that of traditional vegetable oils demonstrating to be a sustainable and green alternative to food oils for industrial applications.

Acknowledgements.
This research was conducted within the activities of the RTD-A contract (no. 1112/2021, Prot. no. 0165823/2021) co-funded by the University of Pisa in respect of the PON "Ricerca e Innovazione" 2014-2020 (PON R&I FSE-REACT EU), Azione IV.6 "Contratti di ricerca su tematiche Green". Casillo Next Gen Food company is kindly acknowledged for providing the waste wheat bran.