**Valorisation of orange peel for bacterial cellulose production via fermentation with simultaneously production of value added products**

Dimitrios Ladakis, Harris Papapostolou\*, Elina Kopanou, Apostolos Koutinas

*Agricultural University of Athens, Iera Odos 75, 11855, Athens, Greece;*

*\*Corresponding author: harris\_papapostolou@yahoo.gr*

**Highlights**

* Orange peel
* Bacterial cellulose
* Biorefinery development

**1. Introduction**

Citrus residues represent an interesting renewable feedstock because of its wide availability and propensity to yield chemicals and materials. The worldwide citrus production in 2016/17 was 63.3 million tonnes with oranges dominating market share at 80 %. 1 Citrus peel represent the 50% of the total fruit mass and considered as low-value by-product stream from the corresponding processing industries. Orange peels contains bio-active compounds such as D-limonene and pectin as well as important amounts of carbohydrates (potentially more than 80 % of peel weight) 2 that can be used as feedstock for the production of fermentative products such as bacterial cellulose.

Bacterial cellulose (BC), is a highly functional biopolymer that can be find applications in numerous sectors including pharmaceutical, broadcasting, food industry, paper manufacture and mining. Bacterial cellulose (BC) produced mainly via fermentative procedures of Acetobacter species utilizing numerous carbon sources. This study evaluates the potential development of a biorefinery concept focusing on the utilization of orange peels for the production of BC and various value-added co-products.

**2. Methods**

The valorization of orange peels starts with the recovery of soluble sugars followed by the extraction of bioactive compounds (D-limonene and pectin) while the remaining solid fraction (mainly cellulose) was treated with commercial hydrolytic enzymes. Soluble sugars were removed with water at 60 oC, D-limonene extraction was carried out using the hydro-distillation method and the pectin using acidified water at pH 1.5 with 0.5 M HCI. The remaining solid residue was treated with commercial enzymes for the production of a sugar rich hydrolysate. The hydrolysate mixed with the fraction of the soluble sugars and used as a substrate for bacterial cellulose production via fermentation using the bacterial strain of *Komagataeibacter sucrofermentans* DSM 15973.

**3. Results and discussion**

The hydrolysate of the orange peel in combination with soluble sugar consist an eventual feedstock for the cultivation of K. sucrofermentans leading to a bacterial cellulose concentration of 6.4 g/L, a yield equal to 0.34 g/L and a productivity of 0.61 g/L/d. D-limonene and pectin extraction reach the values of 3.2 g and 12 g per 100 g of dry orange peel respectively.

**4. Conclusions**

Orange peel is an attractive raw material for the production of bio-based products. The bacterial strain of Komagataeibacter sucrofermentans DSM 15973 efficient cultivated in low cost feedstock derived from orange peel treatment with adequate production of bacterial cellulose in high yield and productivity values.

**References**

[1] https://apps.fas.usda.gov/psdonline/circulars/citrus.pdf (accessed in 23th of May, 2018).

[2] L. A. Pfaltzgraff, M. De bruyn, E. C. Cooper, V. Budarin and J. H. Clark. Food waste biomass: a resource for high-value chemicals. Green Chem., 2013, 15, 307-314.

**Acknowledgments**

We acknowledge support of this work by the project “Research Infrastructure for Waste Valorization and Sustainable Management of Resources, INVALOR” (MIS 5002495) which is implemented under the Action “Reinforcement of the Research and Innovation Infrastructure”, funded by the Operational Programme "Competitiveness, Entrepreneurship and Innovation" (NSRF 2014-2020) and co-financed by Greece and the European Union (European Regional Development Fund).



Co-financed by Greece and the European Union