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Orange peel waste: a powerful resource for future biopolymer production.

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Abstract

According to the Statistical Database of the Food and Agriculture Organization of the United Nations (FAOSTAT), world fruit production is estimated to be 64 million tons. A high percentage of this production (approximately 70%) is used to manufacture products such as juice or marmalade. The end-life of the peel waste is often landfilled or incinerated. The last process represents a very energy consuming process due to the high-water content of the disposed waste material. Under the current influence of the circular economy concept, food waste could be processed into complete bio-exploitation for production of valuable chemicals, which could find application in a vast heterogenous market (Negro et al., 2017).

Each year up to 20 million tons of orange peel waste (OPW) is produced. Around 50% of the orange fruit ends up as waste after processing, wherefrom the orange peel makes up around 60%. Currently most of the orange peel waste (OPW) is landfilled, incinerated, or used as animal feed, which are energetically and economically non beneficial (Mohsin et al., 2022). Taking into account the chemical composition of this waste material, OPW still contains valuable components such as essential oils (limonene), carbohydrates (pectin, cellulose) as well as soluble sugars and enzymes, which can be under environmentally friendly conditions recovered and/or upcycled for further applications.

In particular, microbial production of biopolymers represents a technology that could greatly reduce the production of plastic directly from petrochemicals. Production of PLA and PHB for examples are a well-established technology, which find applications in packaging, textile, or biomedicine fields due to their biocompatibility and biodegradability. Increasing the production of such polymers from waste streams (e.g orange peel waste) can establish a great pillar for bio-circulary economy. (Patti & Acierno, 2022).

This study proposes a holistic valorization route for OPW. Here, value-added products such as limonene and plant-based peroxidase were successfully extracted from OPW. With an additional purification step, 8.2 g L^{-1} limonene were reached. Extracted peroxidase showed high levels of activity, which demonstrates that OPW is a potential source for plant-based peroxidases. To close the loop, OPW was enzymatically hydrolyzed after extraction to obtain fermentable sugars. Beside lactic acid with *W. coagulans*, 44 % P(3HB) per CDM from *P. megaterium* were obtained. The so obtained

valuable chemicals and biopolymers could be finally used for novel bioplastic formulation which can be used for examples in food-packaging application.

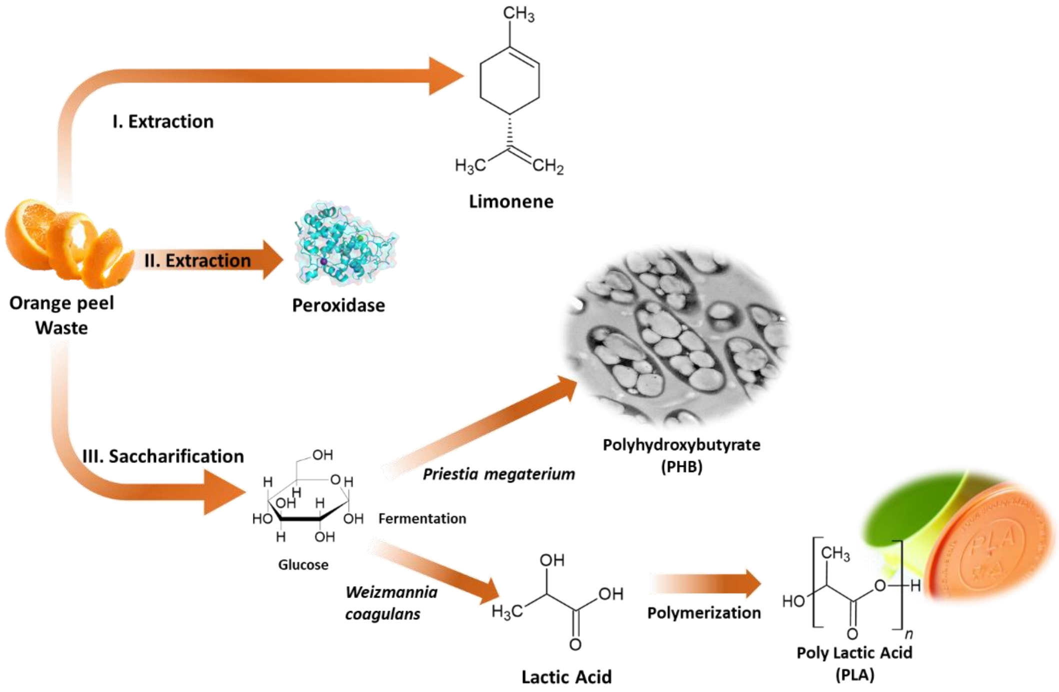

Figure 1 Schematization of OPW recycling and upcycling process

References

Negro, Viviana, et al. "Life cycle assessment of orange peel waste management." *Resources, Conservation and Recycling* 127 (2017): 148-158.

Mohsin, Ali, et al. "Advances in sustainable approaches utilizing orange peel waste to produce highly value-added bioproducts." *Critical Reviews in Biotechnology* 42.8 (2022): 1284-1303.

Patti, Antonella, and Domenico Acierno. "Towards the sustainability of the plastic industry through biopolymers: properties and potential applications to the textiles world." *Polymers* 14.4 (2022): 692.