Fungi-based biorefinery model for food industry waste

Progress toward a circular economy

Pedro F. Souza Filho

Thesis for the degree of Doctor of Philosophy at the University of Borås to be publicly defended on **Sep 28th 2018**, **10:00 AM** in room **E310**, University of Borås, Allégatan 1, Borås, Sweden.

Language: English

Faculty opponent is:

Prof. Satinder Kaur Brar

Eau Terre Environnement Research Centre

Institut National de la Recherche Scientifique

Canada

PhD Thesis is available at:

Swedish Centre for Resource Recovery

University of Borås

SE-501 90 Borås. +46 (0) 33 435 4000

UNIVERSITY
OF BORÅS

Abstract

The food industry, one of the most important industrial sectors worldwide, generates large amounts of biodegradable waste with high organic load. In recent years, the traditional management methods to treat this waste (e.g., landfilling) have been considered not suitable because they do not exploit the potential of the waste material. Alternatively, valorization of food industry waste via a biorefinery model using filamentous fungi is considered to represent an attractive strategy because it minimizes the negative impacts while recovering the nutrients and energy of the waste, in accordance with the concept of the circular economy.

In this thesis, four food processing wastes were utilized as case studies: potato protein liquor (PPL, the soluble fraction of potato starch production waste), the peels wasted during orange juice production, the starchy byproduct of pea protein processes, and the wastewater of a wheat-starch plant. *Rhizopus oryzae*, a zygomycetous filamentous fungus, was grown with these wastes as a substrate, yielding biomass containing 43% (w/w) protein together with 51% removal of the chemical oxygen demand when cultivated in tenfold-diluted PPL. Moreover, protein-rich biomass was produced using the pea-processing byproduct (55%) and wheat-starch wastewater (51%). In contrast, cultivation in orange peel extract yielded a biomass rich in lipids (20%). The use of PPL was also studied in terms of the economy of fungal cultivation. The biotreatment was found to require only 46% of the capital investment necessary for treating PPL by the traditional strategy (application as fertilizer). In comparison, the ascomycetous fungus *Aspergillus oryzae* yielded superior results compared to those of *R. oryzae* when grown in the starchy residues. The high protein content of the fungal biomass encouraged the investigation of its use for bioplastic production. The addition of 20% fungal biomass in a pectin matrix increased the tensile yield of the film and reduced the elongation at break. Moreover, a positive effect on water vapor permeability of the film was also observed.

These results indicate the ability of the filamentous fungi to convert resources wasted by the food industry into new products with positive impacts on the economy and the environment.

Keywords: Filamentous fungi; circular economy; biorefinery; food industry; fungal biomass; bioplastic; resource recovery.