**Valorisation of municipal solid waste for succinic acid production via continuous fermentation and value added products through biorefinery**

Eleni Stylianou, Dimitrios Ladakis, Chrysanthi Pateraki\*, Apostolos Koutinas

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

*\*Corresponding author: paterakichr@aua.gr*

**Highlights**

* Organic fraction of municipal solid waste (OFMSW)
* Biorefinery development
* Continuous fermentation
* Technoeconomic evaluation

**1. Introduction**

Nowadays renewable resources can be used as a potential feedstock for the production of biobased and value-added products. Municipal solid waste (MSW) generation is continuously increasing worldwide. The organic fraction of municipal solid waste (OFMSW) contains high amounts of lipids, protein, pectins and complex polysaccharides. Valorisation of OFMSW though a biorefinery approach could lead to the production of value-added products. Hydrolysis of OFMSW results in the production of a carbon and nutrient rich fermentation supplement. Succinic acid is one of the most important platform chemicals in the bio-economy era. Succinic acid production via continuous fermentation can lead to increased productivities, resulting in an economic feasible process. In this study OFMSW was hydrolysed with commercial enzymes and value-added products (lipids, proteins, pectins) have been subsequently extracted through biorefinery development. OFMSW hydrolysate has been used as the sole fermentation feedstock for the production of succinic acid by *A. succinogenes* via fed-batch and continuous fermentations. Furthermore, technoeconomic evaluation for succinic acid production has been carried out.

**2. Methods**

The organic fraction of municipal solid waste (OFMSW) was treated with commercial hydrolytic enzymes. Furthermore, through biorefinery development lipids were recovered with hexane and proteins were separated using ultrafiltration with 3 kDa membrane cut-offs. The remaining fraction was treated with acidified water at high temperatures and pectins were recovered with ethanol precipitation. OFMSW hydrolysate was used for continuous fermentations with *Actinobacillus succinogenes* 130Z in a 2L bench top bioreactor. Different dilution rates were evaluated in continuous cultures. The temperature was 37 ◦C, agitation was 100 rpm and continuous sparging of CO2 at 1 vvm flow rate were contestant throughout the fermentation. C6 and C5 sugars and organic acids were analysed by high-pressure liquid chromatography (HPLC) with refractive index (RI) detector (Shimadzu) and an HPX-87H (7.8 x 300 mm) column (Aminex). The temperature of the column was 65 °C and the mobile phase was a 10 mM H2SO4 aqueous solution with 0.6 mL/min flow rate. A techno-economic analysis of continuous fermentations was developed in order to investigate the commercial viability of biotechnological succinic acid production. The process design of the mass and energy balances was developed in Unisim software.

**3. Results and discussion**

OFMSW hydrolysate sugar concertation was around 90 g/L. The major carbon source fraction was glucose (84.5 %) followed by xylose (8.4 %), while glycerol, sucrose, galactose, arabinose, mannose and fructose were less than 2.5 %. Free amino nitrogen and inorganic phosphorus concentration was 203.6 mg/L and 100.6 mg/L, respectively. Lipids, proteins and pectins were recovered from the MSW hydrolysate at 90%, 50% and 40% yields, respectively. OFMSW hydrolysate was utilized for succinic acid production in fed-batch and continuous mode. Fed-batch fermentation in OFNSW hydrolysate resulted in more than 35 g/L of succinic acid. Continuous fermentation was carried out at different dilution rates and productivity achieved was higher than 1.5 g/L/h using OFMSW hydrolysate. Technoeconomic evaluation resulted in a minimum celling price of succinic acid below 2.5 $/kg.

**4. Conclusions**

OFMSW is an ideal raw material for the production of biobased products. Furthermore, various value-added products could be extracted from OFMSW. Succinic acid production was carried out in fed-batch and continuous cultures using OFMSW hydrolysate as the sole carbon source.

**Acknowledgments**

Received funding by the Bio Based Industries Joint Undertaking under the European Union’s Horizon 2020 research and innovation programme, grant agreement No 745828, entitled “Chemical building blocks from versatile MSW biorefinery” (Acronym: PERCAL).

