Research Summary Sheet

Summary of Deliverable 4.1 /3

Biotechnological strategies to convert biomolecules from agro-wastes: Fruit and vegetable waste

Context and Challenges

In 2013, the global production of fruits and vegetables reached 1.74 billion tons, which was 10% higher than the value in 2012 and it was still in an increasing trend in recent years. Meanwhile, open markets generate significant quantities of fruit and vegetable waste (FVW), but limited information is available regarding the quantities discarded. Disposal of the FVW improperly pollutes soil and water, causing environmental problems, with loss of resources as they are rich in moisture and carbohydrates, some even containing considerable quantities of proteins and fats which can be converted to value-added products. Currently, FVW has attracted increasing interest and several FVW-based products including bio-fuels, enzymes, flavoring compounds and organic acids have been successfully developed.

Succinic acid (SA), as a versatile building block which holds a wide variety of applications in detergent/surfactant, food, and pharmaceutical industries, has drawn great attention over recent years. Nevertheless, most of the SA is still produced by petrochemical process.

The objectives of SEE and UM were to obtain glucose-rich hydrolysate from FVW by enzymatic hydrolysis and to investigate the feasibility of using this hydrolysate as a generic fermentation feedstock in SA fermentation by Yarrowia lipolytica. SEE aims to recover the highest amount of glucose via enzymatic hydrolysis. Also, SA production was enhanced via optimization of fermentation medium with hydrolysate. SEE also targets for improved SA pro-duction via strategies including in-situ fibrous bed bioreactor (isFBB) and fed batch fermentation.

In order to examine the feasibility of utilising FVW hydrolysate as a generic fermentation feedstock in SA production by Y. lipolytica, shake flask fermentation with FVW hydrolysate as sole feedstock was conducted. Fer-mentation with pure glucose as carbon source was set as the control group. Similarly, shake flask fermentation using fructose as carbon source in SA production by Y. lipolytica was carried out in order to demonstrate the feasibility of fructose as carbon source. The effects of various nitrogen sources and of the initial glucose concentration on SA fermentation were studied. To investigate the performance of SA production from FVW hydrolysate by Y. lipolytica with an optimal nitrogen source,

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free cell batch fermentation was conducted in a 2.5 L bench-top bioreactor. FVW hydrolysate with an initial glucose concentration of 100 g L^{-1} was selected based on our former study. In order to improve SA productivity in batch fermentation, isFBB fermentation was applied in this study with 100 g L^{-1} glucose-containing FVW hydrolysate and 4% corn steep liquor (CSL) as fermentation medium.

Results and Applications

Mixed fruit and vegetable waste hydrolysate was used for the first time for SA production via an engineered Y. lipolytica. In this study, hydrolysis parameters were first optimized and the resultant hydrolysate with the final glucose concentration at 56.7 g L^{-1} was obtained. The feasibility of using this hydrolysate for SA production by Y. lipolytica was then demonstrated and the resultant SA titer of 43.1 g L^{-1} was achieved from free cell batch fermentation with optimized fermentation medium. Finally, is FBB and fed batch fermentation were used for improved SA production, and the productivity of 0.69 g L^{-1} h^{-1} and a SA titer of 140.6 g L^{-1} were attained, respectively.

Breakthroughs, benefits and added value

This work is a good example of valorization of fruit and vegetable waste stream used for the production of high-value added product, which is in line with the sustainable development of circular economy.

Further information on NoAW project: http://noaw2020.eu

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