RESTRUCTURING A CONVENTIONAL WINERY INTO A SUSTAINABLE BIOREFINERY VIA INTEGRATION OF SUCCINIC ACID PRODUCTION AND VALUE-ADDED CO-PRODUCTS

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ABSTRACT

This study focuses on the sustainability assessment of the potential of converting a typical conventional winery into an innovative biorefinery for the production of bio-based succinic acid (SA) and value-added co-products, namely crude phenolic-rich extract (CPE), grape seed oil (GO), calcium tartrate (CaT) and crude tannin-rich extract (CTE). The vinification process is considered and designed, while the by-product of the process, namely grape pomaces, grape stalks and wine lees are subsequently valorised for biorefinery development. This study assesses the holistic valorisation of all major winery waste streams and the potential reduction in succinic acid production cost through integrated biorefinery development. Moreover, focus is given on the contribution of the co-products into the sustainability performance of the wine production.

In 2022, global wine production amounted to about 258 million hectoliters. The production of 0.7 L wine requires approximately 1 kg of grapes, while during the vinification of 1,000 m3 of wine, 82.5 t grape pomace on a dry basis (db), 35.7 t grape stalks (db) and 85.7 t wine lees are generated. Therefore, in this study, a detailed process design of the vinification process is carried out including the bottling[1], while the winery waste streams are further treated for the extraction of value added products (CPE, GO, CaT and CTE), a sugar-rich hydrolysate production and finally the fermentative production of SA[2]. Process design is carried out with the design software UniSim (Honeywell). Techno-economic evaluation is based on preliminary economic analysis (accuracy up to ± 30%). A discounted cash flow (DCF) analysis is carried out in order to estimate the minimum selling price (MSP) of SA considering the biorefinery development. Moreover, the discounted payback period (DPP) and the Net Present Value (NPV) are also estimated for the whole plant to indicate the profitability potential of such scenario. Life Cycle Assessment (LCA) is performed using the GaBi software. The system boundaries for the analysis is “cradle to gate”, while different functional units are considered for comparison purposes. A consequential LCA is also considered to highlight the effect of the biorefinery development into the wine production as final product.

KEYWORDS: Wine, Biorefinery development, Process design, Sustainability assessment

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