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Bioelectrochemical systems as a technological solution for successful anaerobic treatment of recalcitrant wastewater

Marone A.¹, Carmona-Martínez A.A.¹, Sire Y.², Meudec E.³, Steyer J.P.¹, Bernet N.^{1,*} and Trably E.¹

¹ INRA, UR0050, Laboratoire de Biotechnologie de l'Environnement, Avenue des Etangs, Narbonne, F-11100, France

² INRA, UE999 Unité Expérimentale de Pech-Rouge, F-11430, Gruissan

³ INRA, UMR1083 Sciences pour l'œnologie, Montpellier

* Corresponding author : nicolas.bernet@supagro.inra.fr

ABSTRACT

This work proposes a new biotechnological route for an emerging environmental biorefinery technology handling table olive processing wastewater (TOPW). This wastewater is currently considered to be recalcitrant but can become a valuable substrate for energy recovery via novel microbial electrochemical technologies (MET)¹.

MET are really promising since they possess a huge potential for application in many disciplines (bioremediation, wastewater treatment, biofuel and biochemical production). In a completely environmentally compatible way, they are regarded as a new sustainable and effective strategy for treatment of recalcitrant compounds in wastewater. TOPW is of major environmental concern since they are generated in large quantities and are characterized by a high organic content. About 15600 m³ of TOPW are indeed directly discharged into evaporation ponds each year² while TOPW exhibits antimicrobial, ecotoxic and phytotoxic properties due the presence of phenolic compounds. This latest aspect, together with high concentrations of NaCl and NaOH, makes TOPW unsuitable for complete treatment by conventional biological processes³. The objective of this work is to demonstrate the feasibility to apply MET to treat TOPW and simultaneously recover energy in form of CH₄. The experiments were conducted in single chamber systems potentiostatically controlled and fed with real TOPW, using a moderate halophilic consortium as biocatalyst. To increase the efficiency of the process, an enrichment procedure of electroactive biofilm was evaluated. A methane production of 700 ± 10 mL_{CH₄}/L_{TOPW} combined with a Coulombic Efficiency (CE) of 30% and a maximum current density of 7.1 ± 0.4 A.m⁻² were observed with the raw TOPW. In comparison only 69 ± 69 mL_{CH₄}/L_{TOPW} were obtained in the control reactor, with no applied potential. After enrichment of the electroactive biofilm, the CE increase up to 94% and the yield of produced CH₄ almost doubled (1356 ± 37 mL_{CH₄}/L_{TOPW}), despite the maximum current density obtained was lower (5.3 ± 0.4 A.m⁻²). Up to 80% of the major polyphenols (i.e. hydroxytyrosol and tyrosol) detected in the untreated TOPW were removed and new biochemical conversion pathways were revealed. Analysis of the anodic microbial communities by CE-SSCP and sequencing showed a successful enrichment of both anode-respiring bacteria (ARB) belonging to the order of *Desulfuromonadales*, (*Desulfuromonas* and *Geoalkalibacter* genera) and methane-producing archaea from the *Metanomicrobia* class.

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