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Polyphenols removal in winery wastewater using an AnSBR

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Abstract
The aim of this work was to study along of different cycles the biomass adaptation process to total polyphenols (TPP) concentrations in an Anaerobic Sequencing Batch Reactor (AnSBR) and to evaluate the degradation of TPP and COD in winery wastewater (WWW). A lab-scale AnSBR was operated at 30º C with intermittent stirring and was fed with WWW with a COD of 182.25 g/l and a TPP concentration of 489 mg/l. The AnSBR was operated in four cycles, after the first cycle the biomass adaptation was taken for granted since reductions in the TPP went from 56% in C1 to around 95% in the consecutive cycles. COD reduction reached the 95% to 99% for all the four cycles.

Keywords
Anaerobic digestion; AnSBR; polyphenols; winery wastewater.

INTRODUCTION

Winery wastewater (WWW), is a major source of environmental pollution due to its high organic load and to the significant presence of total polyphenols (TPP). Phytotoxic effects and antibacterial activity of the WWW have been associated with its monocyclic phenolic component while the typical color of such wastewaters is due to the more recalcitrant polymeric phenols. Anaerobic digestion (AD) is a well-established technology, which can achieve both goals of WWW decontamination and valorization of the organic fraction by means of biogas production [2]. The anaerobic sequencing batch reactor (AnSBR) is known for its flexibility for allowing the solids retention time (SRT) to be independent from the hydraulic retention time (HRT) contributing to an efficient nutrient removal and to an improvement in the effluent quality. This also makes possible to regulate the concentrations of inhibitory compounds for the anaerobic bacteria to allow the acclimatization of the biomass [3]. Nevertheless, studies by Donoso-Bravo et al. (2009) [4] demonstrate a very low biomass adaptation to phenol concentrations (500 mg COD/l) after 55 days, achieving a maximum removal of 30%.

The aim of this work was to study along of different cycles the biomass adaptation process to TPP in an AnSBR starting from an inoculum which has been found to be adapted for the treatment of sewage sludge from winemaking waters [5] and to evaluate the degradation of TPP and COD in the WWW.

MATERIALS AND METHODS

Experimental set-up

For the AnSBR operation, a glass reactor with a total volume of 2.5 L and effective volume of 2.25 L was used. The AnSBR was installed in a controlled-temperature room that together with a heating plate helped to main the reactor at 30 ± 1º C. A magnetic stirrer was used together with a timer to control the intermittent stirring in the AnSBR for 15 min each hour. To feed substrate and withdraw effluent, two peristaltic pumps were used. The reactor was fed with wine wastewater collected after the red vinification from the experimental winery Mas Friars, Centre linked to the Faculty of Oenology of Universitat Rovira i Virgilli at Tarragona, Spain, together with macro and micro nutrients solutions and $NaCO_3$ to maintain a stable pH. The inoculum was collected from an anaerobic

co-digestion plant at Vilasana (Lleida, Spain) which treated, among other co-substrates, sludge from a winery wastewater treatment plant [5].

Analytical methods

Total solids (TS), volatile solids (VS), total suspended solids (TSS) and volatile suspended solids (VSS) were analysed according to Standard Methods for Examination of Water and Wastewater. COD was measured with a Hanna Instruments COD kit, EPA methods. The total polyphenols (TPP) were determined spectrophotometrically with a UV-Vis spectrophotometer (Perkin Elmer Model-Lambda 35) at 760nm using the Folin test [6].

RESULTS AND DISCUSSION

Data from four different cycles were obtained (C1, C2, C3, C4). The first cycle, C1, lasted 52 days achieving a 54% TPP reduction in day 25 regarding the initial substrate (489 mg/l) with no significant reduction in the consecutive days, reaching only the 56% TPP reduction by the end of the cycle. However, the efficiency in the reduction of COD was better, reaching a 99% reduction of COD by day 52 regarding the initial substrate (182.25 g COD/l). Consecutive cycles showed a better adaptation of the biomass to the concentrations of TPP, resulting in an improvement of the degradation of TPP and COD in a shorter HRT (Figure 1). The TPP degradation in C2, C3 and C4 was around the 95% while the COD reduction reached the 95%-98%. An evolution in the SRT was observed going from 257 d in C1 to 499 d in C3.

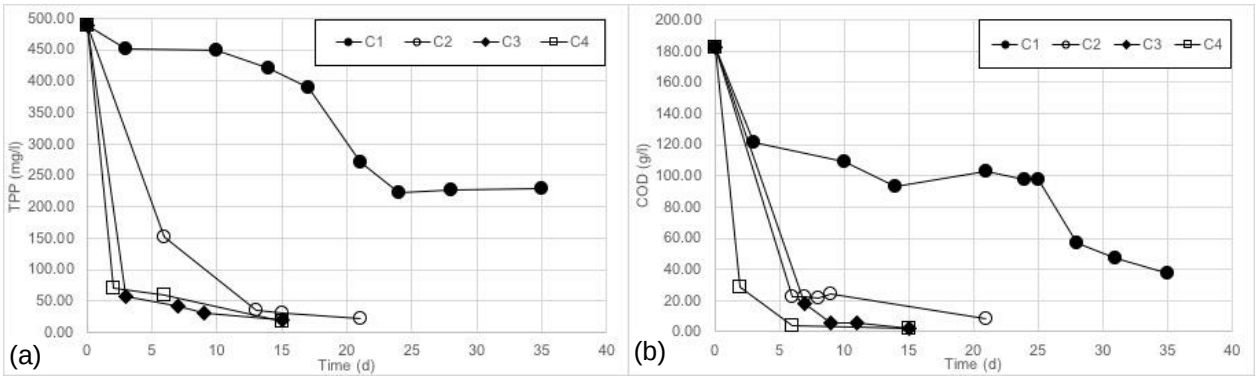

Figure 1. Performance of the AnSBR in the reduction of (a) TPP concentration and (b) COD concentration along different cycles.

CONCLUSIONS

The reduction of the concentration of total polyphenols in an effluent is possible by using an AnSBR while allowing adequate adaptation of the biomass to the specific substrate and maintaining an optimum solids retention time.

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