Polyphenols removal in winery wastewater using an AnSBR

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Abstract
The aim of this work was to study, with the help 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 30° C with intermittent stirring and fed with WWW with a COD of 182.25 g/l and a TPP concentration of 489 mg/l. The AnSBR was operated in six cycles, after the first cycle the biomass adaptation was taken for granted since reductions in the TPP went from 56% in the first cycle to around 95% in the consecutive cycles in shorter cycle time. COD reductions were above 95% in all six 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 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) thereby 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 for 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

For the AnSBR operation, a glass reactor with a total volume of 2.5l and effective volume of 2.25 l was used. The AnSBR was operated at 30 ± 1° C in a controlled-temperature room

together with a heating plate. A magnetic stirrer was used together with a timer to control the intermittent stirring in the AnSBR for 15 min per 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 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].

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.

RESULTS AND DISCUSSION

Data from six different cycles were obtained. In the first cycle, C1, a TPP reduction of 54% (initial concentration of 489 mg/L) was achieved in day 25 but showed no significant reduction in the consecutive days. The final TPP reduction at the end of the cycle (day 52) was 56%. However, at the end of C1, the efficiency in the reduction of COD was found to be better, reaching a 99% reduction of COD (initial COD was 182.25 g /l). Consecutive cycles showed a better adaptation of the biomass to the concentrations of TPP, resulting in an improvement in the degradation of TPP and COD at a shorter cycle time (Figure 1). The TPP degradation in C5 and C6 was around the 95% while the COD reduction reached 98%, favoring subsequent cycle times to be below 10 days. SRT was maintained above 100 days during all the cycles.

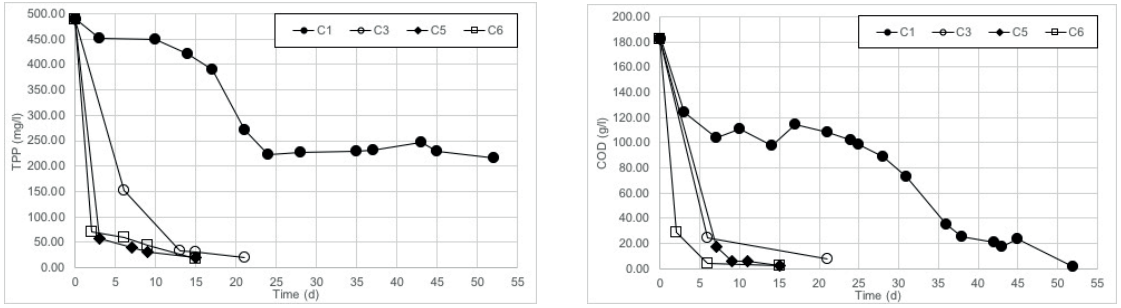

Figure 1. Performance of the AnSBR in the reduction of (a) TPP concentration and(b) COD concentration along different cycles. Cycles 2 and 4 not shown due to low number of samples.

CONCLUSIONS

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

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REFERENCES

[1] Melamane, X. L., Tandlich, R. and Burgess, J. E. 2007 'Treatment of wine distillery wastewater by high rate anaerobic digestion', *Water Science and Technology*, **56**(2), pp. 9–16.

[2] Bolzonella, D., Zanette, M., Battistoni, P. and Cecchi, F. 2007 'Treatment of winery wastewater in a conventional municipal activated sludge process: Five years of experience', *Water Science and Technology*, **56**(2), pp. 79–87.

[3] Wang, L. K., Shammas, N. K. and Hung, Y. T. 2011 *Advanced Biological Treatment Processes*. Humana Press (Handbook of Environmental Engineering).

[4] Donoso-Bravo, A., Rosenkranz, F., Valdivia, V., Torrijos, M., Ruiz-Filippi, G. and Chamy, R. 2009 'Anaerobic sequencing batch reactor as an alternative for the biological treatment of wine distillery effluents', *Water Science and Technology*, **60**(5), pp. 1155–1160.

[5] Nayak, A., Ortiz-Cabrera, M., Flotats, X. 2017 Characteristics of inoculum suitable for degradation of polyphenols in wine wastewaters by anaerobic digestion. *Proceedings of the 15th World Congress on Anaerobic Digestion (AD15)*, Beijing (China).