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Chromium removal from a real tanning effluent by autochthonous and allochthonous fungi

Valeria Prigione [a], Mirco Zerlottin [b], Daniele Refosco [b], Valeria Tigini [a], Antonella Anastasi [a], Giovanna Cristina Varese [a,*]

[a] Department of Plant Biology, University of Turin, Viale Mattioli, 25, 10125 Turin, Italy
[b] Acque del Chiampo S.p.a. – Servizio Idrico Integrato, Via Ferraretta, 20, 36071 Arzignano (Vi), Italy

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ABSTRACT

Heavy metals represent an important ecological and health hazard due to their toxic effects and their accumulation throughout the food chain. Conventional techniques commonly applied to recover chromium from tanning wastewaters have several disadvantages whereas biosorption has good metal removal performance from large volume of effluents. To date most studies about chromium biosorption have been performed on simulated effluents bypassing the problems due to organic or inorganic ligands present in real industrial wastewaters that may sequestrate the Cr(III) ions. In the present study a tanning effluent was characterized from a mycological point of view and different fungal biomasses were tested for the removal of Cr(III) from the same tanning effluent in which, after the conventional treatments, Cr(III) amount was very low but not enough to guarantee the good quality of the receptor water river. The experiments gave rise to promising results with a percentage of removed Cr(III) up to 40%. Moreover, to elucidate the mechanisms involved in biosorption process, the same biomasses were tested for Cr(III) removal from synthetic aqueous solutions at different Cr(III) concentrations.

1. Introduction

Increasing industrial development and urbanisation has resulted in generation of large quantities of toxic substances, introduced into the environment with risk for living organisms, and potentially constituting serious hazards to public health. The presence of toxic heavy metal contaminants in aqueous streams, arising from dumping of metal containing effluents into water bodies, is one of the most important environmental issues (Melgar et al., 2007; Kumar et al., 2008).

Chromium is naturally found in rocks, soil, plants, animals, volcanic dust and gases and exists primarily as the soluble, highly toxic Cr(VI) anions and the less soluble and less toxic Cr(III) (Kumar et al., 2008), which is the most stable valence state of chromium, in aqueous media, at pH values between 4 and 10 (Calfa and Torem, 2008). Even if Cr(III) is an essential element, it can be toxic at elevated concentrations in the environment (Calfa and Torem, 2008). Chromium has widespread industrial applications, such as tanning industries, electroplating, textile dying, wood preservation, as well as finishing of metals and plastics. As a result of these applications, chromium enters in the effluent streams, thereby affecting the environment adversely (Agrawal et al., 2006). Conventional methods for removing metals from aqueous solutions include chemical, physical methods (chemical precipitation, chemical oxidation or reduction, ion exchange, filtration, electrochemical treatment, reverse osmosis, membrane technologies, evaporation recovery, etc.) and activated sludge biological treatment (Ahluwalia and Goyal, 2007). These processes are generally efficient in removing the bulk of metal from solution at high or moderate concentrations, whereas they may be ineffective or extremely expensive especially when the metals in solution are at low concentration i.e. in the range of 1–100 mg l^{-1} (Ahluwalia and Goyal, 2007). As a consequence, their limits (high cost, high reagent requirements, etc.) become more pronounced when voluminous effluents containing complexing organic matter and low metal contamination must be treated. Biotechnological approaches can succeed in those areas and are designed to cover such niches (Malik, 2004).

Among biotechnological techniques, biosorption is viewed as one of the most valuable choices for the removal of heavy metals from wastewaters. Recently, the discovery of biosorbents, which exhibit a favourable cost-efficiency relationship, when compared to conventional sorbents (i.e. activated carbon and ion exchange resins), has been proved to be a reality (Calfa and Torem, 2008). Microorganisms including bacteria, filamentous fungi and yeasts are found to be capable of efficiently accumulating heavy metals. The ability of fungi to act as biosorbents has been extensively

* Corresponding author. Tel.: +39 011 6705984; fax: +39 011 6705962.
E-mail addresses: valeria.prigione@unito.it (V. Prigione), cristina.varese@unito.it (G.C. Varese).

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