Desalination 259 (2010) 216–222

Contents lists available at ScienceDirect

Desalination

journal homepage: www.elsevier.com/locate/desal

Removal of natural humic acids by decolorizing actinomycetes isolated from different soils (Algeria) for application in water purification

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ARTICLE INFO

Article history:
Received 4 October 2009
Received in revised form 1 April 2010
Accepted 2 April 2010
Available online 14 May 2010

Keywords:
Natural humic acids
Streptomyces
Actinomycetes
Decolorization
Biodegradation

ABSTRACT

Humic acids are considered problematically in drinking water because it can react readily with chlorine to form carcinogen compounds and its biological removal is much recommended. The scanning electron microscopy morphologies and optical parameters observed for natural humic acids (NHAs) extracted from different soils at Mitidja plain (Algeria) made them different from the commercial ones. Three of the most active strains of 19 actinomycetes were isolated and selected from surface soils at this plain. These strains were identified based on cultural characteristics and chemotaxonomic analysis and classified in the genus *Streptomyces*. Growth of these strains was assured on a poor liquid medium containing NHAs as carbon and nitrogen sources and degradation occur only in the presence of glucose. A maximal decolorization extent was obtained for 28 days at 30 °C under shake culture (67%, 66% and 57% for *Streptomyces* sp. strain AB1, *Streptomyces* sp. strain AM2 and *Streptomyces* sp. strain AH4, respectively). As compared with initial and final structures of NHAs after incubation (28 days), the structural changes in FTIR spectrum and metabolite products analyzed by HPLC indicate the capability of the selected *Streptomyces* sp. strains to degrade HAs and to play a part role in humus turnover in natural waters.

1. Introduction

Humic substances (HS) can be operationally divided into three fractions based on their solubility in aqueous solutions as a function of pH. Humic acid (HAs) is the fraction soluble in an alkaline solution, fulvic acid (FA) is the fraction soluble in an aqueous solution regardless of pH, and humin is the fraction insoluble at any pH value. The characteristic that remains associated with each humic fraction after their separation from a natural organic matter (NOM) sample is the high degree of their heterogeneity [1].

It is now known that several microorganisms, including fungi, actinomycetes and bacteria, can decolorize and even completely mineralize HAs under certain environmental conditions. The changes in the chemical properties of a limited range of HAs degraded (and therefore decolorized) by actinomycetes have been investigated [2–4]. There has been great progress in the analytical methods which can be used to characterize humic substances [5–9]. By applying these methods during biodegradation, a better understanding of the mechanisms governing this process can be achieved.

In addition, the HA fraction of NOM is considered problematically in drinking water because it can react readily with chlorine to form carcinogen compounds. Therefore, there exist two reports on endemic diseases that are harmful to those who used to drink well water near peat bogs: Kaschin–Beck disease, a chronic osteoarthritic disorder with necrosis of condrocytes prevailing in China [10]. HAs can form complexes with heavy metals and hydrophobic polychlorinated organics [11], influencing their fate and transport [12].

The Mitidja plain a North location of Algeria is known for its fertility and a rapid disappearance of natural humic acids causing saturation of surface waters by FA-like metabolite products (Ghrib and Keddara dam's waters, north of Algeria) [13]. Until now, this has been the first report on the decolorizing actinomycetes being isolated and identified from surface soils and we suggest that they may play a significant role in the turnover of HS in local soils and surface waters. Moreover it seems that these actinomycetes are the major element causing rapid disappearance of natural humic acids in this plan. Therefore, the aim of the present work was (1) to find out the potential of actinomycetes isolated locally for the degradation of NHAs under static and shaking conditions at laboratory scale and (2) to study the structural changes of these macromolecules used as

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doi:10.1016/j.desal.2010.04.001