ISSN 0003-6838, Applied Biochemistry and Microbiology, 2018, Vol. 54, No. 1, pp. 45–52. © Pleiades Publishing, Inc., 2018.
Original Russian Text © E.A. Saratovskikh, V.A. Shcherbakova, R.N. Yarullin, 2018, published in Prikladnaya Biokhimiya i Mikrobiologiya, 2018, Vol. 54, No. 1, pp. 55–62.

Nitrocellulose Degradation by the Fungus *Fusarium solani*

E. A. Saratovskikh[a], *, V. A. Shcherbakova[b], and R. N. Yarullin[c]

[a] *Institute of Problems of Chemical Physics, Russian Academy of Sciences, Chernogolovka, Moscow oblast, 142432 Russia*
[b] *G.K. Skryabin Institute of Biochemistry and Physiology of Microorganisms, Russian Academy of Sciences, Pushchino, Moscow oblast, 142290 Russia*
[c] *Kazan (Volga region) Federal University, Kazan, 420008 Russia*
**e-mail: easar@icp.ac.ru*

Received May 10, 2017

Abstract—The degradation of native and pretreated nitrocellulose (NC) by the microscopic fungus *Fusarium solani* VKM F-819 and a mixed culture of the fungus with a sulfate-reducing bacterium *Desulfovibrio desulfuricans* VKM B-1388 has been studied. It has been shown that NC pretreatment with UV radiation and ozone promoted its subsequent biodegradation. The degradation of the thus treated NC by a mixed culture of *F. solani* and *D. desulfuricans* was the most effective as compared to all other treatment options. The NC nitrogen content decreased from 13.38 to 10.03%; the number average (M_n) and weight average (M_w) molecular masses decreased by three and two times, respectively. These magnitudes were achieved after 5 days of incubation of the pretreated NC. The obtained data can be used to further develop NC degradation technology.

Keywords: nitrocellulose, biological oxidation, *Fusarium solani*, *Desulfovibrio desulfuricans*
DOI: 10.1134/S0003683818010106

INTRODUCTION

Nitrocellulose (NC) is used in the manufacture of explosives, varnishes, paints, membrane filters, and other products for various industries. Its production results in large quantities of waste, which is considered hazardous substances. The problem of its utilization is very important and complex, and its solution is inextricably linked to the health of present and future generations of humans.

Various means of NC waste recycling and disposal, including membrane separation, thermal denitrification, and biological treatment methods, are currently being explored [1, 2]. Although many studies demonstrated NC resistance to the biological treatment [3], the authors of some studies achieved partial NC destruction with the use of fungi [4–9] or bacteria in anaerobic reactors [10]. Several studies in the literature concerned screening to find the fungi that are the most effective destructors of NC or other hard-to-degrade nitro-derivatives (Table 1). The following factors influencing NC degradation were identified: the medium composition, cultivation conditions, accumulation of the products inhibiting key enzymes involved in the degradation, and the presence of sterically hindered functional groups [11]. Mixed cultures containing denitrifying bacteria and cellulolytic fungi were considered for application [12, 13]. The influence of the initial NC content in the fungal growth medium on the rate of degradation was studied [14]. It was shown that the introduction of cosubstrates such as starch or xylan to the fungal medium is needed, in addition to NC as the main nitrogen source [15].

It is often necessary to use preliminary physicochemical or chemical treatment of substrates that are hard to degrade by fungi [3] in order to obtain substances digestible by microorganisms and to improve the efficiency of the degradation process. Photocatalytic ozonation is successfully applied for destruction of a wide range of organic low-molecular and polymer compounds due to the high oxidizing ability of formed free radicals [22, 23]. This process is used in some technologies for the pretreatment of materials containing cellulose; in particular, an attempt has been made to apply UV radiation for NC destruction [24].

The goal of the work was to study the degree of NC oxidation by the fungi of the genus *Fusarium* and mixed culture of *Fusarium solani* with bacteria *Desulfovibrio desulfuricans* and the impact of preliminary NC treatment with UV radiation and ozone on this process for potential use in industrial wastewater cleaning and the detoxification of settling ponds.

MATERIALS AND METHODS

Reagents

The chemicals and solvents for the preparation of culture media and buffer systems and for the performance of physicochemical studies included KCl, NH_4Cl, $CaCl_2 \cdot 2H_2O$, K_2HPO_4, $MgCl_2 \cdot 6H_2O$,