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Biotransformation of coal derived humic acids by Basidiomycetes

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Introduction

Low energetic coals and wastes of coal industry are promising sources for biologically active compounds including humic acids (HA). Aside from evident advantages of biocatalytic approaches for coal slime conversion such as environmental safety and cost efficiency they also could be used for the improving of HAs biological activity [1, 2]. The aim of the present study was to provide molecular characterization of the HAs formed during biotransformation of coal slime by Basidiomycetes under different cultivation conditions.

Materials and methods

Biotransformation of brown coal from Solncevskoe deposit (Sakhalin, Russia) was performed by liquid surface cultivation of pure culture Coriolus hirsutus 075 (Wulf. Ex. Fr.) Quel. with rich (contained glucose as a carbon source) and poor (without readily available carbon source) nutrition medium. After 30 days of cultivation coal HAs were separated by alkaline extraction followed by dialysis desalting and drying at 50[U+F0B0]C. HAs derived were characterized using size-exclusion chromatography, Fourier transformed infrared (FTIR) and 13C NMR spectroscopy.

Results and discussion

Molecular weight distribution of HA was not significantly affected by Basidiomycetes under all cultivation conditions studied in comparison to HAs extracted from non-conversed coal.

FTIR spectra of HA obtained were typical for HAs. Biotransformation of coal did not result in appearance of new functional groups. The exception was observed under rich media conditions where absorbance at 1700 cm-1 was determined related to carbonyl groups of carboxyl and ketonic fragments. Therefore, the revealed phenomena could be explained with additional formation of the above carbonyl groups in the course of biotransformation process.

Quantification of 13C NMR spectra revealed decrease of aromatic structures in HA extracted from coal after biotransformation under poor media conditions. Also a significant increase in carboxylic fragments content was observed. So, core aromatic structures could be hypothesized to be oxidized by fungi under biotransformation in poor medium. The latter was evident for the fact that when carbon source was absent in the nutrition media, fungi were able to utilize carbon of coal as a nutrition source. On the contrary, in case with biotransformation under rich media conditions, considerable increase in aromatic structures was observed for HA as compared to those extracted from non-treated coal. Besides, decrease in content of aliphatic structures was demonstrated. So, we could conclude that if carbon source was available in the nutrition media, fungi could utilize only readily available peripheral fragments of coal.

Conclusions

The performed experiments on biotransformation of coal demonstrated clearly that mean of coal degradation by fungi depended drastically on availability of carbon source in the nutrition media. Our findings indicated that basidiomycetes Coriolus hirsutus 075 were able to utilize carbon of coal as a nutrition source when no other readily available carbon source was presented in the nutrition media.

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