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sa međunarodnim učešćem

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Bioremediation of river sediment contaminated with polychlorinated biphenyls: a laboratory study

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Persistent organic pollutants (POPs) are chemical substances that persist in the environment, bioaccumulate through the food chain and cause adverse effects on human health and the environment [1, 2]. They include the group of polychlorinated biphenyls (Polychlorinated Biphenyls, PCBs), industrial chemicals which may be substituted with 1 - 10 chlorine atoms (Fig 1.) [3-6].

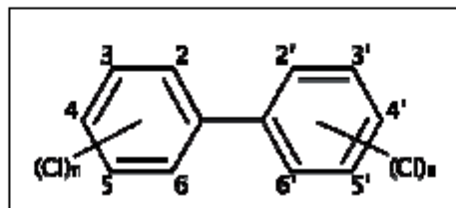


Figure 1. Chemical structure of PCBs

Due to their chemical inertness, heat resistance and high dielectric constants PCBs were used as insulators in transformers and capacitors, as heat exchangers, color additives and in the production of plastics [3-6].

The aim of our study was to analyze the potential of allochthonous and autochthonous microorganisms for the process of biodegradation of PCBs in sediment samples collected from rivers in the territory of Belgrade, Serbia, to protect the environment and estimate future treatment of these sites. The river sediment samples were collected from four locations in the territory of Belgrade: confluence of the Topčider river with Čukarički Rukavac (CR), Marina Dorćol (MD), Zemunski Kej (ZK) and the confluence of the river Sava and the Danube, Ušće (U). Sediments were sampled from four depths in undisturbed condition as follows: 0-1, 1-3, 3-6 and 6-10 cm. The highest level of PCB in a sample is determined in CR sediment (169-305 ng/g) and MD (19.3-54.5 ng/g), while the sample concentration in ZK (6.2-7.1 ng/g) and U (2.1-5.3 ng/g) were relatively low.

For the PCBs bioremediation study composite samples has been made from the samples sampled from four depths in the ratio 1: 2: 3: 4 (w/w). In Bushnell - Haas medium (modified, chloride-free) were added the sand and composite samples, 1: 1 (w/w). The experiment lasted 70 days with alternating anaerobic - aerobic cycles with inoculation of model system at 21st and 56th day. Inoculation was carried using consortium of genera *Pseudomonas* (Genbank: JF826528.1 and JQ292806.1), *Rhodococcus* (Genbank: JQ065876.1 and JX965395.1), and *Achromobacter* (Genbank: JF826529.1). These allochthonous microorganisms were isolated from sites contaminated with petroleum products. In parallel, activity of indigenous microbial consortium in the process of transforming the PCB were monitored. As an abiotic control sterilized sample were used. Biodegradation processes are interrupted by sterilization. Extraction

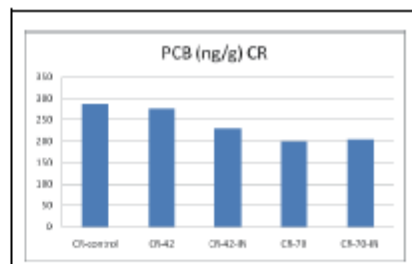


Figure 2. Reduction of PCBs in the CR

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BIOREMEDIATION OF RIVER SEDIMENT CONTAMINATED WITH POLYCHLORINATED BIPHENYLS: A LABORATORY STUDY



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Aim

The aim of our study was to analyze the potential of allochthonous and autochthonous microorganisms for the process of biodegradation of PCBs in sediment samples collected from rivers in the territory of Belgrade, Serbia, to protect the environment and estimate future treatment of these sites.

Introduction

Persistent organic pollutants (POPs) are chemical substances that persist in the environment, bioaccumulate through the food chain and cause adverse effects on human health and the environment [1, 2]. They include the group of polychlorinated biphenyls (Polychlorinated Biphenyls, PCBs), industrial chemicals which may be substituted with 1 - 10 chlorine atoms (Fig 1.) [3-6].

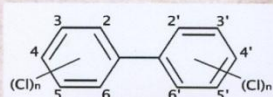


Fig 1. Chemical structure of PCBs

Due to their chemical inertness, heat resistance and high dielectric constants PCBs were used as insulations in transformers and capacitors, as heat exchangers, color additives and in the production of plastics [3-6].

Material and methods

The river sediment samples were collected from four locations in the territory of Belgrade (Fig 2.): confluence of the Topčider river with Čukarički Rukavac (CR), Marina Dorćol (MD), Zemunski Kej (ZK) and the confluence of the river Sava and the Danube, Ušće (U). Sediments were sampled from four depths in undisturbed condition as follows: 0-1, 1-3, 3-6 and 6-10 cm.

For the PCBs bioremediation study composite samples has been made from the samples sampled from four depths in the ratio 1: 2: 3: 4 (w/w). In Bushnell - Haas medium (modified, chloride-free) were added the sand and composite samples, 1: 1 (w/w). The experiment lasted 70 days with alternating anaerobic - aerobic cycles with inoculation of model system at 21st and 56th day. Inoculation was carried using consortium of genera *Pseudomonas* (Genbank: JF826528.1 and JQ292806.1), *Rhodococcus* (Genbank: JQ065876.1 and JX965395.1), and *Achromobacter* (Genbank: JF826529.1). These allochthonous microorganisms were isolated from sites contaminated with petroleum products. In parallel, activity of indigenous microbial consortium in the process of transforming the PCB were monitored. As an abiotic control sterilized sample were used. Biodegradation processes are interrupted by sterilization. Extraction was carried out with a mixture of acetone : hexane, 1: 1 (v/v). PCB content in the obtained samples was analyzed by GC-MS/MS method.

References

- [1] Kemp, L. R., Dunstan, M. S., Fisher, K., Warwick, J., Leys, D., *Phil. Trans. R. Soc. B, Biological Sciences*. 368 (2013) 20120323.
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Fig 2. Sampling locations in Belgrade, Serbia

CR - Čukarički rukavac
ZK - Zemunski kej
MD - Marina Dorćol
U - Ušće

Results and Discussion

The highest level of PCB in a sample is determined in CR sediment (169-305 ng/g) and MD (19.3-54.5 ng/g), while the sample concentration in ZK (6.2-7.1 ng/g) and U (2.1-5.3 ng/g) were relatively low (Fig 3.).

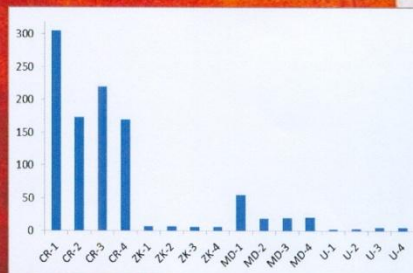


Fig 3. Concentration of PCBs in sediment samples (ng/g)

In Fig 4. changes in concentrations of PCBs in the sample CR during bioremediation studies, after 42 and 70 days in the inoculated and uninoculated samples are presented. The results indicate the existence of bioremediation potential of microorganisms isolated from contaminated sites for the treatment of environment contaminated with PCB compounds using alternating anaerobic - aerobic cycles.

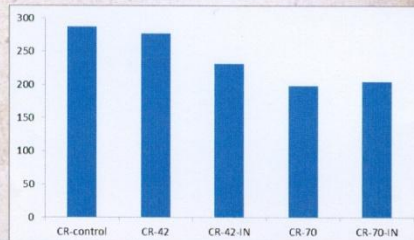


Fig 4. Reduction of PCBs in the CR (ng/g-dry)

Conclusion

In model systems inoculated with consortium of allochthonous microorganisms as well as in model systems with indigenous microorganisms it was observed reduction in the concentration of PCBs. This fact suggests that the mentioned microorganisms can be used in bioremediation of river sediment contaminated with polychlorinated biphenyls.