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Oily waste containing natural radionuclides: Does it cause stimulation or inhibition of soil bacterial community?

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Abstract

© 2015 WILEY-VCH Verlag GmbH & Co. KGaA, Weinheim. Contamination with oily wastes containing natural radionuclides is a potential hazard for soil health and function. Our study aimed to reveal both structural and functional changes of the microbial community resistant to and able to decompose oily wastes in soil. To do this, we determined CO2 efflux, microbial biomass (by the extraction-fumigation method), and community structure (by PCR-SSCP) for 120 d after application of radioactive oily wastes to the soil at the ratio 1:4. The addition of the waste resulted in an increase of the activity concentration of 226Ra by 130 times (up to 643 Bq kg-1) and of 232Th by 29 times (up to 254 Bq kg-1). The calculated weighted dose for the radionuclide 226Ra was found to be below the values that are known to affect microorganisms. However, the cumulative effect of a repeated deposition of radioactive oily waste may result in an increase of the weighted dose up to an effective level. During the incubation, the hydrocarbon (HC) content of the waste-treated soil decreased from 156 to 54 g kg-1 of soil indicating intensive decomposition of added organics by soil microorganisms. The waste application, however, led to an inhibition of soil microbial biomass compared with the control (by 26-47%). Microbial respiration was stimulated in the first month of incubation and then decreased until the end of the incubation period (by up to 74% compared to the control). The qCO2 was estimated to be 3-fold higher than the control on day 1 of incubation and equal to the control on day 120 of incubation. The bacterial diversity decreased in the contaminated soil compared with the control soil. The bacterial community structure was altered by domination of new oil degrader species belonging to the genera Dyella, Pseudoxanthomonas, Sinobacter, and Parvibaculum. Thus, disposal of radioactive petroleum waste strongly altered the structure of the microbial community resulting in the selection of resistant species able to decompose pollutants and also affected the community function (inhibition of microbial biomass and stimulation of respiration) which tended to stabilize after long-term incubation.

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Keywords

Bacterial community structure, Microbial biomass carbon, Microbial respiration, Natural radionuclides, Oily waste