OPINION

The impact of bio stimulation on oil degradation and microbial community composition in a contaminated desert soil using sewage sludge, soybean meal and wheat straw

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ABSTRACT

Due to their significant nutrient content and practical economics, waste materials have a strong potential for the bioremediation of oil-contaminated locations. We induced oil deterioration in a highly contaminated desert soil using sewage sludge, soybean meal, and wheat straw. Gas chromatography-mass spectrometry-mass spectrometry and other methods were used to monitor changes in the composition of the bacterial community while illumine MiSeq was used to track changes in oil degradation. While the addition of soybean meal had no effect on the amount of CO_2 produced given the high respiration activity of the soybean meal alone, the addition of sewage sludge and wheat straw increased the respiration activity to a level 3.2 times–3.4 times greater than in the untreated soil. In the soils treated with sewage sludge and wheat straw, the degradation of almost 90% of the C14 to C30 alkanes was measured. According to MiSeq sequencing, the bulk of the sequences obtained from the untreated soil belonged to Alphaproteobacteria, Gammaproteobacteria, and Firmicutes. The bacterial communities of the soils after the treatments were grouped into distinct clusters by multivariate analysis of operational taxonomic units. The wheat straw treatment showed the most striking change in bacterial populations, with 95%–98% of all sequences belonging to Bacilli. We have come to the conclusion that wheat straw and sewage sludge are effective bio-stimulating agents for cleaning up oil-contaminated desert soils.

Key Words: *Alphaproteobacteria; Gammaproteobacteria; Gas Chromatography; Firmicutes*

INTRODUCTION

Oil contamination causes key nutrients like nitrogen and phosphate to be depleted from the soil as well as a huge rise in carbon sources. The biodegradation process is hampered by the imbalance in the carbon-nitrogen ratio and the lack of nitrogen. Waste products like sewage sludge and soybean meal (referred to as SG and SB, respectively), which are both economically viable and rich in nutrients like phosphorus, nitrogen, and carbon, are potential stimulating agents for bioremediation. SG has been employed in the bioremediation of soil contaminated with metals and oils as an organic fertiliser, a soil ventilator, and a bio augmentation agent. In various contaminated soils, the addition of SG reduced polyromantic hydrocarbons by up to 45% and total petroleum hydrocarbons by 43–98%. The bioremediation of a number of oil-contaminated soils has also exploited SB as a source of organic nitrogen. It has been demonstrated that adding SB improves the synthesis of bio surfactants and raises the bioavailability of hydrocarbons.

In addition to nutrients, oxygen is another limiting component that affects the effectiveness of bioremediation processes, particularly because oxygen-dependent enzymes are required for the initial stage in the breakdown of hydrocarbons under aerobic circumstances. A variety of aeration techniques, including forced aeration, bulking agents, and tilting, were used to quicken the bioremediation process. Increased soil porosity, increased oxygen diffusion, lower bulk density, and the provision of a valuable carbon and energy source for microorganisms are all functions of bulking agents. Wood chips, post-peelings, peanut powder, and wheat straw (hence referred to as WS) have all been employed successfully as aerating agents to biostimulate the development and activity of microorganisms in PAH-contaminated soils. Desert soil bioremediation is difficult, mostly due to the extreme environmental conditions. Comparatively less research has been done on the variety of microorganisms in oil-contaminated arid deserts and how they respond to various bioremediation techniques. Oil spills occur often in the deserts of the Arabian Peninsula, but little research has been done to examine their effects on the environment or how to clean them up.

Here, we look at how the biostimulators SG, SB, and WS affect bacterial community alterations, hydrocarbon degradation, and respiration activities in oil-contaminated soils from the Oman desert. To the best of our knowledge, next-generation high throughput sequencing has rarely been used to examine the response of bacterial activity and diversity in oil-contaminated desert soils to three biostimulating chemicals in a single experiment. NGS has recently developed into a reliable and simple technology with the capacity to produce enormous sequence databases in a massively parallel manner. This method has produced thorough data on the composition of microbial communities and how they change in contaminated loactions.

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