METHANOTROPHIC PRODUCTION OF EXTRACELLULAR POLYSACCHARIDE IN LANDFILL COVER SOILS

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ABSTRACT

A bench-scale soil reactor was employed to study methane oxidation and EPS production under tropical conditions. The study of pertinent environmental factors affecting EPS production was carried out by batch cultivation of methanotrophs. These factors included variations in temperature (20^oC to 45^oC), soil water content (5% to 33%), and the supply ratios of methane/oxygen. The bench-scale study revealed that excessive EPS was accumulating in an active methane oxidation zone located 5-45 cm below the soil surface of the reactor. The observed peak rates of oxidation could not sustain over an extended period of time due to EPS accumulation. Results from the batch cultivation experiments confirmed the production of EPS in soils subject to methane oxidation. EPS production was found to correlate with methane oxidation rates which, in turn, were regulated by the variance of temperature and soil water content. A larger amount of EPS production was obtained at 30^oC and 17% soil water content. Oxygen is required for methane oxidation; however, at high oxygen tension it may accelerate the production of EPS by methanotrophs causing limited oxygen diffusion and declining rates of methane oxidation.

KEYWORDS

Extracellular polysaccharide, landfill cover soil, methane, methanotroph

INTRODUCTION

Over the last two centuries, the atmospheric methane concentrations have been more than doubled due to increasing human-related activities. It has been postulated that a 10 percent reduction of methane emission from anthropogenic souces can effectively control the annual rise in methane emission and contribute to the mitigation of climate change. The emisison of methane from landfills accounts for about 8% of the global contribution of anthropogenic methane sources (IPCC, 1992). Methane finds its way to the atmosphere from a landfill site by escaping through the final soil cover unless it is oxidized by naturally occurring methanotrophs in the cover layer. In other word, biological activities within the landfill cover could serve as an effective sink for the reduction of methane emission. Research on methane oxidation using laboratory soil columns reveals that the peak capacity of methane oxidation could not be sustained over an extended period of time (Kightley et al, 1995). The decline of methane oxidation capacity over time was attributed to the accumulation of extracellular polysaccharide (EPS) excreted by methanotrophic cells in the form of capsule or slime. EPS can be produced by many different types of methanotrophic bacteria including *Methylococcus capsulatus*, *Methylocystis parvus* OBBP, *Methane-oxidizing H-2*, and *Methylomonas methanica* (Dworkin and Foster, 1956, Huq et al, 1978, Hou et al, 1979, Chida et al, 1983). These microorganisms rely on the secretion of EPS as a protective mechanism against unfavorable conditions such as predator, desiccation, and heat tolerance. EPS exists in the form of polysaccharides as part of the insoluble soil component and forms humic substances when combining with clay minerals or certain metals (Smith, 1982). The accumulation of