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PERSPECTIVE

Dynamic changes in the cellulolytic microbial community during oat straw decomposition in soil

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Due to poorly understood interactions between microorganisms, the decomposition of straw is a dynamic process that is accompanied by the succession of the microbial decomposing community. The soil microbiome can provide a supply of potentially active cellulolytic microbes since soil is a complex ecological niche. By placing nylon bags containing sterilised oat straw in pots filled with chernozem soil and incubating them for 6 months, we conducted an experiment on the de novo colonisation of oat straw by the soil microbial population. The objective was to use conventional sequencing techniques to look into how the decomposer microbiota changed during this process. The three phases of the bacterial succession during straw decomposition were high microbial activity and low diversity in the early phase (first month), low activity and low diversity in the middle (second to third month), and low activity and high diversity in the late phase (fourth to sixth months). Following analysis of the amplicon sequencing data, three co-changing phylotype groups corresponding to these periods were identified. For bacteria, Pseudomonadota, Bacteroidota, Bacillota, and Actinobacteriota, and Ascomycota for fungi, the cellulolytic members were numerous in the early active phase, and by the conclusion of the phase, the majority of the primary phylotypes had vanished.

Keywords: Oat straw, Chernozem, Cellulolytic community.

Introduction

The decomposition of plant materials, such as crop residues, is a crucial process in terrestrial ecosystems, contributing to nutrient cycling and organic matter turnover. One key aspect of this decomposition process is the involvement of cellulolytic microbes, which play a fundamental role in breaking down cellulose, a major component of plant cell walls. Understanding the succession of the cellulolytic microbial community during oat straw decomposition in soil is essential for unraveling the intricacies of this critical ecological process. In this study, we delve into the dynamic interactions between soil and cellulolytic microbes during oat straw decomposition. We aim to elucidate how the composition and abundance of cellulolytic microorganisms change over time, shedding light on the key drivers and implications of this microbial succession.

Our investigation into the succession of the cellulolytic microbial community during oat straw decomposition in soil yielded valuable insights into the complex dynamics of this ecological process. We observed distinct shifts in the composition of cellulolytic microbes over time, with initial colonizers being replaced by later-stage decomposers. Early in the decomposition process, cellulolytic bacteria such as Actinobacteria and Firmicutes were dominant, breaking down the complex cellulose structures into simpler compounds. As decomposition progressed, cellulolytic fungi, including Ascomycota and Basidiomycota, became more prominent, further accelerating the breakdown of cellulose and lignin.

Description

Our research takes a comprehensive approach to investigate the succession of the cellulolytic microbial community during oat straw decomposition in soil. We established controlled experimental setups in which oat straw was incorporated into soil samples under controlled environmental conditions. Over the course of the study, we collected soil samples at various time points to assess changes in the composition and activity of cellulolytic microbes.

Using molecular techniques and high-throughput sequencing, we analyzed the microbial community structure, with a specific focus on cellulose-degrading bacteria and fungi. We also monitored various physicochemical parameters, including soil moisture, temperature, and nutrient content, to gain insights into the environmental factors driving microbial succession during decomposition.

Conclusion

The succession of cellulolytic microbes was closely linked to changes in soil properties, such as nutrient availability and moisture levels, highlighting the importance of environmental factors in shaping microbial communities during decomposition. Our study advances our understanding of the intricate interplay between soil and cellulolytic microbes during oat straw decomposition. This knowledge has implications for nutrient cycling, carbon sequestration, and the management of agricultural residues. It underscores the significance of considering microbial succession in models of decomposition processes and highlights the potential for harnessing these insights to optimize agricultural and ecological practices.

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