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Antibiotic Effects on Microbial Communities Responsible for Greenhouse Gas Emissions

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Introduction

- Nitrous oxide (N₂O) is a powerful greenhouse gas depleting the stratospheric ozone.
- Recent studies show that fungi produce N₂O by denitrification.
- Bacteria can be a source or sink of N₂O depending on the presence of nitrous oxide reductase genes (nosZ).
- Fungal denitrification produces N₂O as an end product due to lack of nosZ genes.

\[
\text{NO}_3^- \rightarrow \text{NO}_2^- \rightarrow \text{NO} \rightarrow \text{N}_2 \text{O} \rightarrow \text{N}_2
\]

Denitrification. Step-wise reduction of nitrate (NO₃⁻) to nitrite (NO₂⁻), nitrite (NO) and N₂O to N₂. The nosZ gene is present in bacteria but is missing in fungi.

- Higher fungal denitrification can increase soil N₂O emissions.
- Animal manure application affects N₂O emissions from agricultural fields.
- Antibiotics carried in the animal manure due to livestock administration mostly repress bacteria, promoting fungal growth.

Objective

To study the effects of antibiotics on microbial communities responsible for N₂ and N₂O production in agricultural soils and estuarine sediments

Methods

- North Dakota Soil Sampling (16 cores)
- Soil Laboratory Experiments (1 week)
- Soil Mesocosm Experiment (1 month)

Results

- Soil Laboratory Experiments (1 week incubations)

![Figure 1](image1.png)  
Figure 1. Rates of N₂ (A) and N₂O (B) production measured in soil slurry incubations with tetracycline. Different concentrations of tetracycline were used. Water was added to the controls. Columns represent mean ± SE.

- Soil Mesocosm Experiment (1 month)

![Figure 3](image3.png)  
Figure 3. N₂O cumulative fluxes measured in soil mesocosms treated with manure and antibiotic. Tetracycline in the manure (2 mg Kg⁻¹) was applied to the soil cores. Markers represent mean ± SE.

Conclusions

1. N₂O production was enhanced 8 times in the soils treated with high concentration of tetracycline.
2. Antibiotic inhibition of N₂ production was dose-dependent, reaching 25 and 80% inhibition in the samples treated with 0.5 mg Kg⁻¹ and 1,000 mg Kg⁻¹ of tetracycline, respectively.
3. Higher abundance of fungi with decreasing bacterial abundance was observed after tetracycline exposure.
4. Cumulative N₂O fluxes in the mesocosm experiment show that the application of manure contaminated with tetracycline enhances soil N₂O emissions.

Acknowledgements

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