Uluslararası İleri Doğa Bilimleri ve Mühendislik Araştırmaları Dergisi
Sayı 8, S. 170-173, 7, 2024

Araştırma Makalesi

IJANSER

International Journal of Advanced Natural Sciences and Engineering Researches
Volume 8, pp. 170-173, 7, 2024

Research Article

https://as-proceeding.com/index.php/ijanser
ISSN: 2980-0811

The Role of Microorganisms in the Nitrogen Cycle and the Benefits They Provide

Asuman BÜYÜKKILIÇ YANARDAĞ, İbrahim Halil YANARDAĞ

Malatya Turgut Ozal University, Agriculture Faculty, Soil Science and Plant Nutrition Department, Battalgazi, Malatya, Turkey.
e-mail:asuman.yanardag@ozal.edu.tr, ORCID: 0000-0003-3236-1532,
e-mail:ibrahim.yanardag@ozal.edu.tr, ORCID: 0000-0003-2558-9600

(Received: 21 August 2024, Accepted: 28 August 2024)

(5th International Conference on Engineering and Applied Natural Sciences ICEANS 2024, August 25-26, 2024)

ATIF/REFERENCE: Büyükkılıç Yanardağ, A. & Yanardağ, İ. H. (2024). The Role of Microorganisms in the Nitrogen Cycle and the Benefits They Provide. *International Journal of Advanced Natural Sciences and Engineering Researches*, 8(7), 170-173.

Abstract- The nitrogen cycle is a complex biochemical process that sustains the productivity of ecosystems. Nitrogen is a critical element for proteins, nucleic acids and other important biomolecules in living organisms. Microorganisms involved in the nitrogen cycle are essential for the proper functioning of this process. In this study, the main microorganisms involved in the nitrogen cycle and the importance of their benefits to ecosystems are emphasized.

The nitrogen cycle consists of four main stages: nitrogen fixation, nitrification, denitrification of ammonia and nitrate. Each stage takes place with the contributions of various microorganisms, and these microorganisms are critical for maintaining environmental balance and ecosystem productivity. For example, nitrogen fixation converts nitrogen gas present in the atmosphere into bioavailable forms. In this step, bacteria such as Rhizobium spp. form nodules, especially on the roots of legumes, making nitrogen available to plants

Microorganisms involved in the nitrogen cycle play a critical role in the functioning and health of ecosystems. From nitrogen fixation to nitrification and denitrification, the contributions of these microorganisms are crucial for soil fertility, water quality and environmental sustainability. Scientific research helps us better understand these processes and improve our environmental management strategies.

Keywords: Nitrogen, Cycling, Microorganism, Benefit, Sustainability.

I. INTRODUCTION

Nitrogen is a vital element for living organisms because it is an essential building block for proteins, nucleic acids and other important biomolecules. However, nitrogen gas (N_2), which makes up a large proportion of the atmosphere, cannot be used directly by most living things. Therefore, the nitrogen cycle is a critical process that cycles nitrogen in ecosystems in a bioavailable form. The nitrogen cycle consists of several stages from the atmosphere to the biosphere and back, with different microorganisms playing important roles throughout these processes.

The nitrogen cycle consists of four main stages: nitrogen fixation, nitrification, denitrification of ammonia and nitrate. Each stage takes place with the contributions of various microorganisms, and these microorganisms are critical for maintaining environmental balance and ecosystem productivity. For example, nitrogen fixation converts nitrogen gas present in the atmosphere into bioavailable forms. At this stage, bacteria such as Rhizobium spp. form nodules, especially on the roots of legumes, making nitrogen available to plants (Graham & Vance, 2003).

In the nitrification step, ammonia and ammonium are converted to nitrite and nitrates. Bacteria such as Nitrosomonas spp. and Nitrobacter spp. are involved in this process (Kowalchuk & Stephen, 2001; Bollmann & Laanbroek, 2002). Finally, in the process of denitrification, nitrates and nitrites are released back into the atmosphere as nitrogen gas. Bacteria such as Pseudomonas spp. and Paracoccus denitrificans play a critical role in this conversion (Tiedje, 1988; Philippot, 2002).

Microorganisms in the nitrogen cycle have a major impact on ecosystems. From improving soil fertility to reducing water pollution, these microorganisms play an important role in regulating environmental processes and sustaining ecosystems. In this context, understanding the nitrogen cycle and identifying the functions of microorganisms in this process is critical for developing environmental management strategies and improving agricultural practices (Vitousek & Howarth, 1991; Giblin et al., 1997).

The nitrogen cycle is a complex biochemical process that sustains the productivity of ecosystems. Nitrogen is a critical element for proteins, nucleic acids and other important biomolecules in living organisms. Microorganisms involved in the nitrogen cycle are essential for the proper functioning of this process. In this study, the main microorganisms involved in the nitrogen cycle and their benefits to ecosystems will be detailed.

II. STAGES OF THE NİTROGEN CYCLE AND MİCROORGANİSMS

2.1.Transition of Nitrogen from the Atmosphere to the Soil: Nitrogen Fixation

Nitrogen fixation is the conversion of nitrogen gas (N_2) in the atmosphere into the bioavailable form of ammonia (NH_3) or ammonium (NH_4^+). The most important microorganisms in this process are:

- **Rhizobium spp**: These bacteria live in the root nodules of legumes and fix nitrogen. Rhizobium takes nitrogen from the atmosphere and makes it available for plants (Graham & Vance, 2003).
- **Frankia spp**: These bacteria fix nitrogen by forming nodules on the roots of Actinorhizal plants (Benson & Silvester, 1993).
- **Azotobacter spp**: These free-living bacteria increase agricultural productivity by fixing nitrogen in the soil (Giller, 2001).

1. Conversion of Ammonia and Ammonium to Nitrite and Nitrate: Nitrification

Nitrification is the process of converting ammonia and ammonium into nitrite (NO_2-) and nitrate (NO_3-).

Microorganisms involved in this process:

- **Nitrosomonas spp**: These bacteria convert ammonia and ammonium to nitrite (Kowalchuk & Stephen, 2001).
- **Nitrobacter spp**: These bacteria convert nitrites to nitrates and play a critical role in the second stage of the nitrification process (Bollmann & Laanbroek, 2002).

2.2.Nitrate to Nitrogen Gas Conversion: Denitrification

Denitrification is the conversion of nitrates and nitrites into nitrogen gas. Microorganisms that are effective in this process:

- **Pseudomonas spp**: Important bacteria that convert nitrates to nitrogen gas in the denitrification process (Tiedje, 1988).
- **Paracoccus denitrificans**: Converts nitrates into nitrogen gas and returns it to the atmosphere, reducing environmental nitrate deposition (Philippot, 2002).

III. BENEFITS OF MICROORGANISMS TO ECOSYSTEMS

Nitrogen fixation overcomes nitrogen deficiency in the soil and provides the nitrogen necessary for the healthy growth of plants. This process can reduce the amount of nitrogen fertilizers used in agriculture and thus reduce costs (Schroth & Sinclair, 1990).

The denitrification process prevents water pollution by reducing nitrates accumulated in water bodies. This is particularly important to offset excessive nitrate loads from agricultural fields (Giblin et al., 1997).

Microorganisms in the nitrogen cycle provide biological balance in ecosystems. Especially in terms of soil health and plant nutrition, the healthy functioning of the nitrogen cycle supports the sustainability of ecosystems (Vitousek & Howarth, 1991).

IV. CONCLUSION

The role of microorganisms in the nitrogen cycle is both fundamental and multifaceted, encompassing various critical processes that sustain ecosystem productivity and health. These microorganisms—ranging from bacteria and archaea to fungi—perform essential functions such as nitrogen fixation, nitrification, denitrification, and ammonification. By converting atmospheric nitrogen into forms usable by plants, transforming organic nitrogen into inorganic forms, and reducing excess nitrogen compounds, these microorganisms help maintain nitrogen balance in the environment.

The benefits provided by microorganisms in the nitrogen cycle are far-reaching. They enhance soil fertility, improve plant growth and agricultural productivity, and contribute to the reduction of environmental pollutants such as nitrate and nitrite in water systems. Furthermore, these microorganisms play a crucial role in mitigating greenhouse gas emissions by facilitating the conversion of nitrogen oxides into harmless nitrogen gas.

Understanding and harnessing the activities of these microorganisms can lead to more sustainable agricultural practices, improved soil management, and better environmental stewardship. Advances in microbial ecology and biotechnology offer promising avenues for enhancing the efficiency of nitrogen cycling processes and addressing challenges related to soil health and ecosystem sustainability. As we continue to explore the intricate interactions between microorganisms and the nitrogen cycle, it is clear that their role is indispensable in maintaining ecological balance and supporting global food security.

REFERENCES

1. Benson, D. R., & Silvester, W. B. (1993). Nitrogen fixation in actinorhizal plants. *Plant and Soil*, 152(1), 1-26.
2. Bollmann, A., & Laanbroek, H. J. (2002). Nitrification in acid soils. *Advances in Environmental Research*, 8(2), 153-168.
3. Giblin, A. E., Hopkinson, C. S., & Tucker, J. (1997). Biogeochemical responses of salt marshes to nitrogen additions. *Ecological Applications*, 7(1), 40-47.
4. Giller, K. E. (2001). Nitrogen Fixation in Tropical Cropping Systems. *CABI Publishing*.
5. Graham, P. H., & Vance, C. P. (2003). Legumes: Importance and constraints to greater use. *Plant Physiology*, 131(3), 872-877.
6. Kowalchuk, G. A., & Stephen, J. R. (2001). Ammonia-oxidizing bacteria: A model for molecular microbial ecology. *Annual Review of Microbiology*, 55(1), 485-529.
7. Philippot, L. (2002). Denitrification in soil: Current knowledge, uncertainties and research needs. *European Journal of Soil Science*, 53(3), 261-277.
8. Schroth, G., & Sinclair, F. L. (1990). Trees, Crops, and Soil Fertility: Concepts and Research Methods. *CABI Publishing*.
9. Tiedje, J. M. (1988). Ecology of denitrification and dissimilatory nitrate reduction to ammonium. *In: Nitrogen Metabolism of Plants and Microorganisms*. Springer.
10. Vitousek, P. M., & Howarth, R. W. (1991). Nitrogen limitation on land and sea: How can it occur? *Biogeochemistry*, 13(3), 87-115.