Dissolved organic nitrogen in BNR effluents is not always bioavailable

Uptake by Algae of Dissolved Organic Nitrogen from BNR Treatment Plant Effluents (NUTR1R06e)

The Central Issue

The importance of dissolved organic nitrogen (DON) in wastewater treatment effluent has dramatically increased. This is because permitted effluent total nitrogen (TN) concentrations have been decreased to very low levels in response to problems with impaired surface water quality from eutrophication.

Context and Background

For conventional secondary treatment, DON typically accounts for less than 10% of the effluent TN. However, it can be a major component (>50%) in effluents from advanced biological nutrient removal (BNR) treatment plants, for which most of the inorganic nitrogen species and effluent suspended solids are removed. DON persists in effluents from BNR systems, yet little is known about its potential impact on surface water quality. Of particular interest are what portion of DON is readily available for algae consumption or can be converted to forms to support algal growth, and what types of substances compose DON.

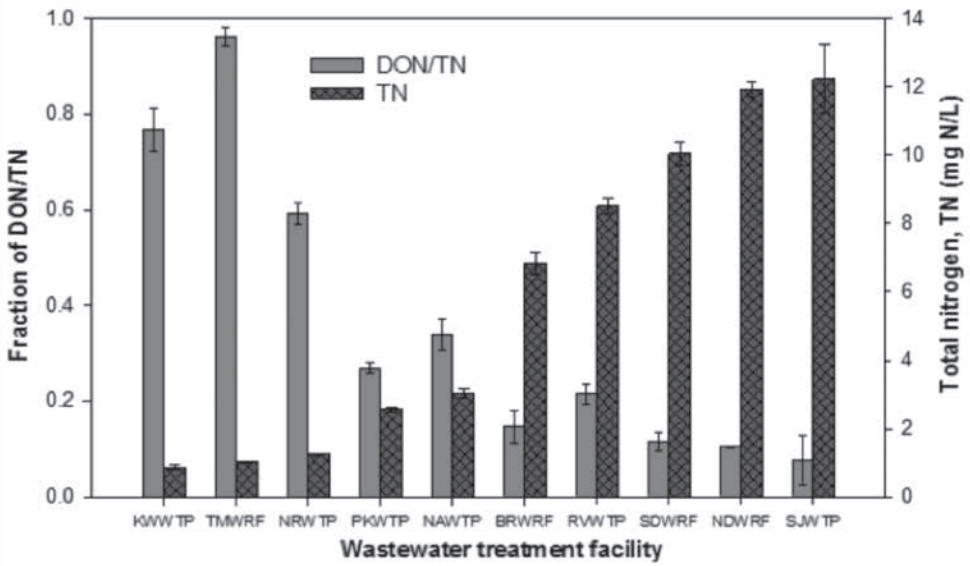
To develop a better understanding of the occurrence and bioavailability of DON in effluents from advanced BNR systems, a new protocol was developed for measuring the readily bioavailable DON and forms of DON that are not readily taken up by algae (recalcitrant DON). An anion exchange resin was used to remove nitrate while an XAD-8 resin was used to remove hydrophobic forms of DON. To assess the bioavailability of wastewater-derived DON, algal growth assays were performed in the presence of bacteria in effluents from 10 municipal BNR wastewater treatment plants.

Findings and Conclusions

The results showed, after nitrate removal, only minor and statistically insignificant differences in algal growth and DON consumption between untreated samples and samples from which the hydrophilic forms of DON were removed. Growth of algae and DON consumption were not observed in the hydrophobic fraction from XAD-8 resin separation, despite the fact that this fraction contained up to approximately 30% of the DON. These findings indicate that the hydrophobic DON retained on the XAD-8 resin is not readily taken up by algae over periods of several weeks. They also indicate that the XAD-8 treatment combined with an anion exchange resin can be used to quantify and separate this recalcitrant form of DON from bioavailable DON and nitrate.

Management and Policy Implications

This research provides an improved protocol for making low-level measurements of dissolved organic nitrogen (DON) in effluent from BNR wastewater treatment plants. It also provides further evidence that BNR wastewater treatment plant effluent contains forms of DON that are not readily available to algae. That evidence provides a basis for more efficient control of nutrient pollution and a more scientific basis for evaluating the impact of effluent DON on surface waters. Finally, it provides a simpler, faster, and robust protocol without extensive bioassay for separating and quantifying readily bioavailable DON from recalcitrant DON in BNR effluents.



Concentrations of total nitrogen (TN) and fractions of dissolved organic nitrogen (DON) in effluent samples from all 10 wastewater treatment plants.

Executive Summary

WERF

Uptake by Algae of Dissolved Organic Nitrogen from BNR Treatment Plant Effluents

Related WERF Research

Project Title	Research Focus
Nutrient Farming and Traditional Removal: An Economic Comparison (03WSM6CO)	Compares total, average, and marginal costs of removing nutrients to the extent necessary to meet recommended nutrient criteria, using conventional wastewater treatment systems and large treatment wetlands, known as nutrient farms.
Greenhouse Nitrogen Emissions from Wastewater Treatment Operations Phase I – Molecular Level Through Whole Reactor Level Characterization (U4R07)	Biological nutrient removal treatment operations can result in the production of gaseous oxidized nitrogen products, which can have a greater greenhouse gas impact than carbon dioxide. This study helps characterize their formation and release so that generation and release are reduced.
Nutrient Management: Regulatory Approaches to Protect Water Quality Volume 1 – Review of Existing Practices (NUTR1R06i)	Provides a better understanding of key nutrient management issues and technical challenges that currently confront point source wastewater dischargers and regulators nationwide in setting and meeting low nutrient effluent limits.
Nutrient Management: Volume 2 – Removal Technology Performance & Reliability (NUTR1R06k)	Comprehensive two-year study of 22 real-world, full-scale nutrient removal plants designed and operated over three years to meet very low effluent TN and TP concentrations (as low as 3 mg/L TN and 0.1 mg/L TP). Provides database for key decision makers about proper choices for both technologies and rationale bases for statistical permit writing.
Striking the Balance Between Nutrient Removal in Wastewater Treatment and Sustainability (NUTR1R06n)	Provides a bench-top analysis on finding the balance between nutrient removal and sustainability in order to determine if a point of diminishing returns is reached where the sustainability impacts of achieving increased levels of nutrient removal outweigh the benefits of better water quality.
Nutrient Removal Workshop: How Low Can We Go & What is Stopping Us from Going Lower? (05CTS1W) **Bioavailability of Wastewater Derived Organic Nitrogen in Treatment Systems and Receiving Waters (NUTR1R06d)** **Maximizing the Dual Benefits of Advanced WWTP Processes: Reducing Nutrients and Emerging Contaminants (Chesapeake Bay STAC, MWCOG, WERF)**	Series of collaborative WERF-sponsored workshops (2006-2008), on nutrient removal, reduction, sources, bioavailability, impacts, and recalcitrance of various wastewater nitrogen species. As wastewater treatment facilities in the Chesapeake Bay implement enhanced nutrient removal and control technology strategies, they also help reduce endocrine disrupting compounds, personal care, and pharmaceutically active compounds. These workshops established what we know and do not know about the various fractions of nitrogen, and led to a coordinated, multi-year research agenda. Joint workshop reports are available at: www.chesapeake.org/stac/Pubs/eonworkshopreport.pdf

Principal Investigator:

David L. Sedlak, Ph.D.
University of California, Berkeley

Research Team:

Joonseon Jeong, Ph.D.
University of California, Berkeley

Haizhou Liu, Ph.D.
University of California, Berkeley

Technical Reviewers:

Michael T. Brett, Ph.D.
University of Washington

Jacek Makinia, Ph.D.
Gdansk University of Technology

Krishna Pagilla, Ph.D.
Illinois Institute of Technology

Robert R. Sharp, Ph.D., P.E.
Hazen & Sawyer

To Order

Contact WERF at **571-384-2100** or visit **www.werf.org** and click on Search Research Publications & Tools.
WERF Subscribers: Download unlimited free PDFs. Non-Subscribers: Charges apply to some products.

Refer to Stock No. **NUTR1R06e**
For more information, contact
Amit Pramanik at **apramanik@werf.org**