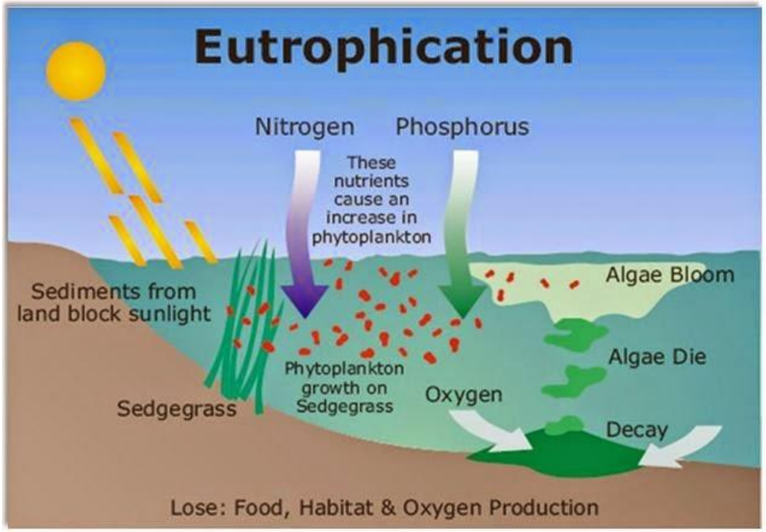
Nutrients removal from anaerobic effluent with *Chlorella vulgaris*.

Alexandra Cerón Vivas – alexandra.ceron@upb.edu.co
J.C. Serrano, M.P. Villamizar, A.M. Ardila, Y. Gamarra

Content

Introduction

Anaerobic treatment



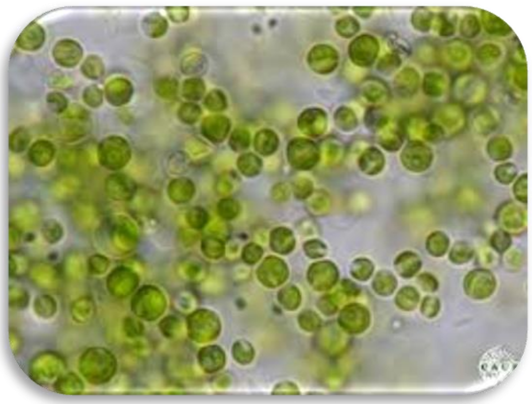
http://wildbioblog.blogspot.com.co/2014/11/eutrofizacion-problema-mundial.html

Introduction

Sunlight

CO_2

MICROALGAE



Chlorella vulgaris

Animal feed

Biomolecules

Biofuel

Biogas

Municipal WW
Domestic WW
Industrial WW
Effluent WW

Nutrients removal

pH control

Objective

Assess the influence of initial ammonium concentration and the initial microalgal biomass concentration on biomass growth and nutrient removal from anaerobic effluent.

Material and methods

Experimental set-up

- C. Vulgaris UTEX 1803
- Bold Basal Medium
- 4700 Lux
- Light/dark = 12/12 h
- pH = 7.5 un
- 500 ml Microalgae
- 500 ml anaerobic effluent

Material and methods

NH_{4o} (mg·L^{-1})	DW_o (mg·L^{-1})		
	94	229	344
68.4	B1N1	B2N1	B3N1
79.6	B1N2	B2N2	B3N2
94.6	B1N3	B2N3	B3N3

Material and methods

Analytical methods

- Microalgal biomass – OD_{550}
- NH_4-N
- PO_4-P

Kinetic modelling

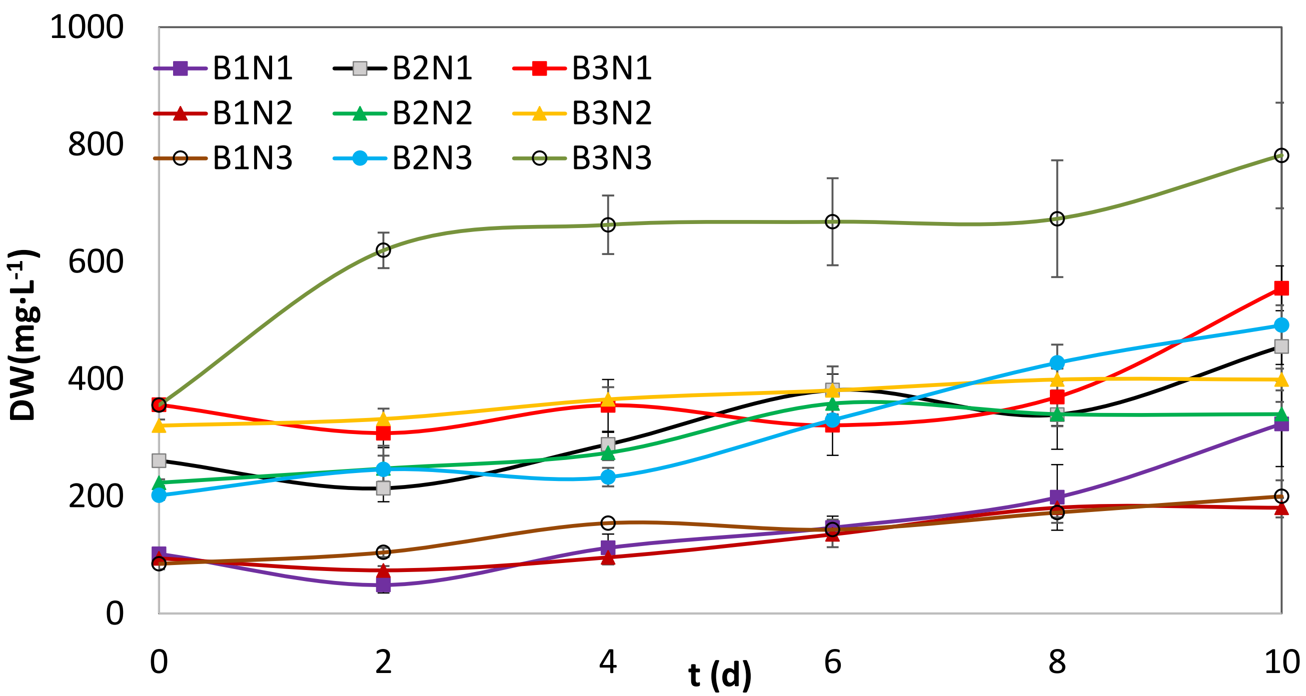
- Initial substrate utilization rate, Ri
- Specific rate of sustrate removal, Rxi

Statistical analysis

- Three way repeated measures ANOVAs

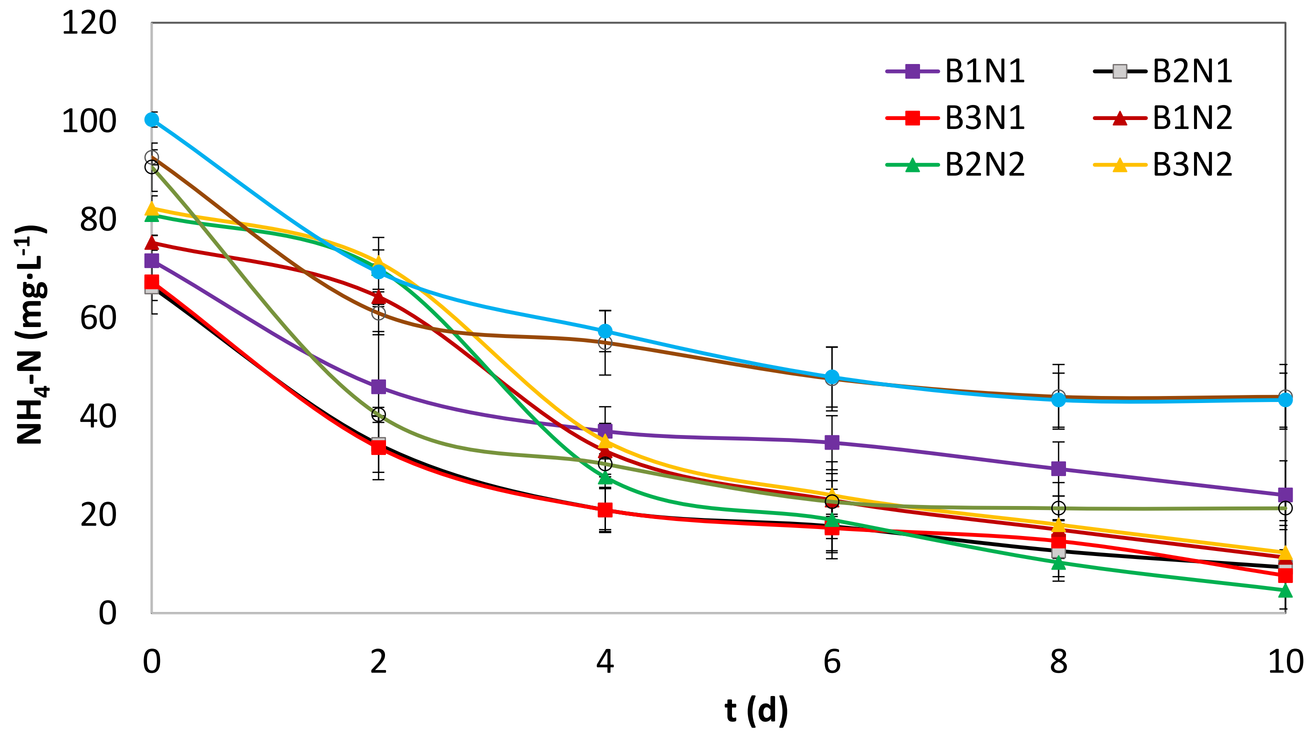
Results and discussion

Influence on microalgae growth



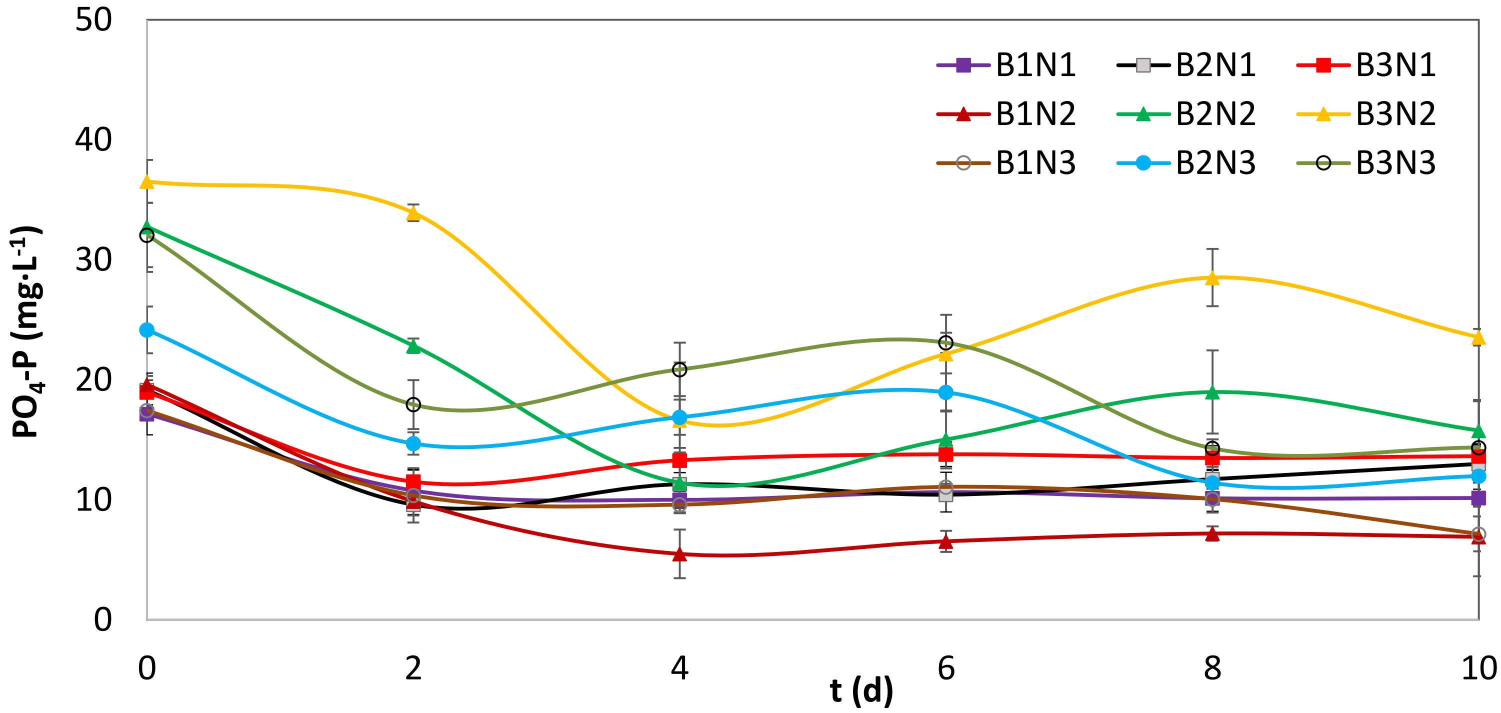
Results and discussion

Influence on nutrients



Results and discussion

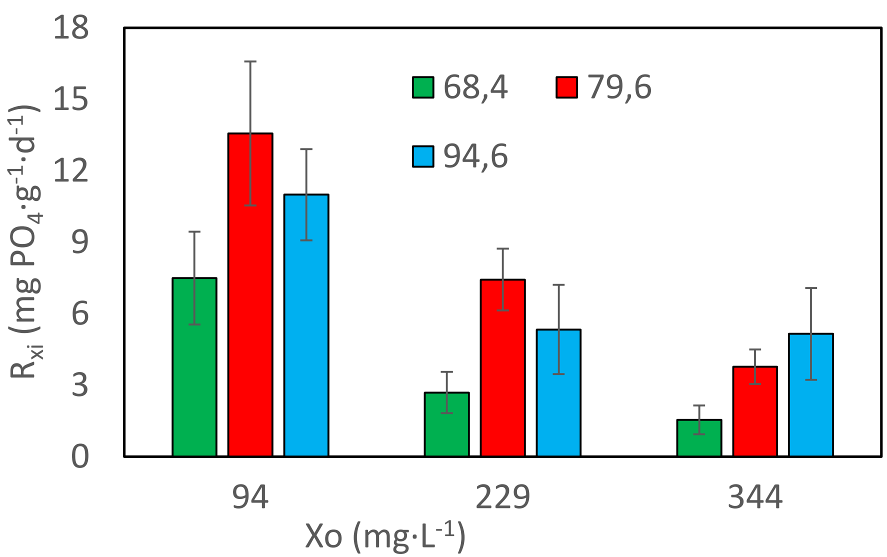
Influence on nutrients

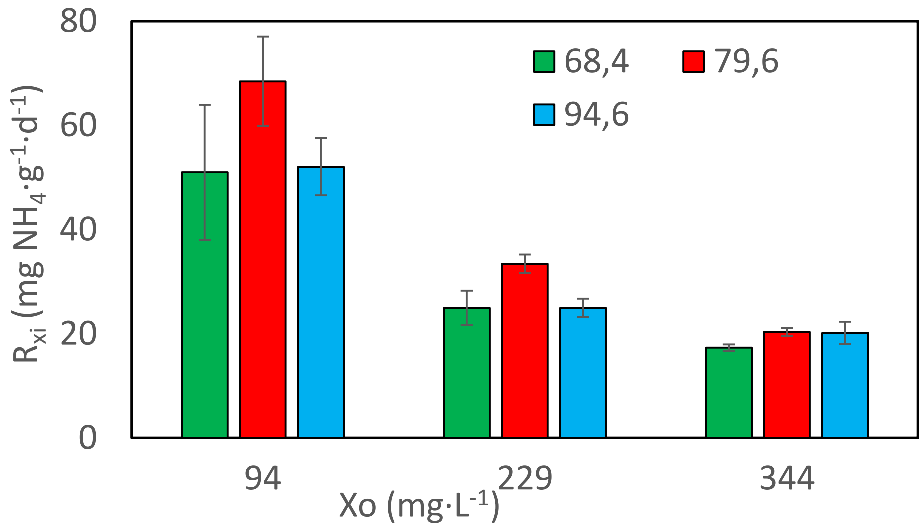


Results and discussion

Nutrients specific removal rates

Phosphates





Ammonium

Conclusions

The initial ammonium concentration and the initial microalgal biomass concentration have a significant effect on nutrient removal and the biomass growth. The results show that B3N3 had the highest biomass (781.4 ± 90.1 $mg{\cdot}L^{-1}$) and the highest specific growth rate (0.60 ± 0.02 d^{-1}). The growth in B1N2 and B1N3 can be inhibited by the high ammonium concentration.

The NH_4-N removal efficiency was the highest and the PO_4-P removal efficiency was approximatively 30% when the initial ammonium concentration was lower. The better specific removal rates for nitrogen and phosphorus in the anaerobically treated effluent occur when DW_o was lower.

Acknowledgements

This study was supported by Research and Transfer Department of the Universidad Pontificia Bolivariana, Bucaramanga, Colombia.

References

APHA, AWWA, and WEF (2012) *Standard Methods for the Examination of Water and Wastewater*, American Public Health Association, American Water Works Association, Water Environment Federation.

Aslan, S. and Kapdan, I. K. (2006) Batch kinetics of nitrogen and phosphorus removal from synthetic wastewater by algae. Ecological Engineering, **28**(1), 64–70. [online] http://linkinghub.elsevier.com/retrieve/pii/S0925857406000759 (Accessed July 15, 2014).

Barrera Bernal, C., Vázquez, G., Barceló Quintal, I., and Laure Bussy, A. (2007) Microalgal Dynamics in Batch Reactors for Municipal Wastewater Treatment Containing Dairy Sewage Water. Water, Air, and Soil Pollution, **190**(1-4), 259–270. [online] http://link.springer.com/10.1007/s11270-007-9598-3 (Accessed July 10, 2014).

Bischoff, H. . and Bold, H. C. (1963) "Phycological studies IV." in Some soil algae from Enchanted Rock and related algal species. Austin, University of Texas, 1–95.

Borowitzka, M. A. and Moheimani, N. R. (2013) *Algae for Biofuels and Energy* (M. A. Borowitzka and N. R. Moheimani, eds.), New York, Springer.

Cai, T., Park, S. Y., and Li, Y. (2013) Nutrient recovery from wastewater streams by microalgae: Status and prospects. Renewable and Sustainable Energy Reviews, **19**, 360–369. [online] http://linkinghub.elsevier.com/retrieve/pii/S1364032112006429 (Accessed July 14, 2014).

Chong, A. M. ., Wong, Y. ., and Tam, N. F. . (2000) Performance of different microalgal species in removing nickel and zinc from industrial wastewater. Chemosphere, **41**(1), 251–257.

De-Bashan, L. E. and Bashan, Y. (2004) Recent advances in removing phosphorus from wastewater and its future use as fertilizer (1997-2003). Water Research, **38**(19), 4222–4246.

Escudero, A., Blanco, F., Lacalle, A., and Pinto, M. (2014) Ammonium removal from anaerobically treated effluent by Chlamydomonas acidophila. Bioresource technology, **153**, 62–8. [online] http://www.ncbi.nlm.nih.gov/pubmed/24342946 (Accessed July 17, 2014).

He, P. J., Mao, B., Lü, F., Shao, L. M., Lee, D. J., and Chang, J. S. (2013) The combined effect of bacteria and Chlorella vulgaris on the treatment of municipal wastewaters. Bioresource technology, **146**, 562–8. [online] http://www.ncbi.nlm.nih.gov/pubmed/23973976 (Accessed July 17, 2014).

References

Hernández, D., Riaño, B., Coca, M., and García-González, M. C. (2013) Treatment of agro-industrial wastewater using microalgae-bacteria consortium combined with anaerobic digestion of the produced biomass. Bioresource technology, **135**, 598–603. [online] http://www.ncbi.nlm.nih.gov/pubmed/23069610 (Accessed July 17, 2014).

Ji, M.-K., Abou-Shanab, R. a. I., Kim, S.-H., Salama, E.-S., Lee, S.-H., Kabra, A. N., Lee, Y.-S., Hong, S., and Jeon, B.-H. (2013) Cultivation of microalgae species in tertiary municipal wastewater supplemented with CO2 for nutrient removal and biomass production. Ecological Engineering, **58**, 142–148. [online] http://linkinghub.elsevier.com/retrieve/pii/S0925857413002218 (Accessed July 17, 2014).

Jiménez-Pérez, M. ., Sánchez-Castillo, P., Romera, O., Fernández-Moreno, D., and Pérez-Martínez, C. (2004) Growth and nutrient removal in free and immobilized planktonic green algae isolated from pig manure. Enzyme and Microbial Technology, **34**(5), 392–398.

Kumar, K., Dasgupta, C. N., Nayak, B., Lindblad, P., Das, D., Hoffmann, J. P., Hernández-Reyes, B. M., Rodriguez-Palacio, M. C., Lozano-Ramírez, C., Castilla-Hernández, P., de-Bashan, L. E., Hernandez, J.-P., Morey, T., Bashan, Y., Sluiter, A., Hames, B., Ruiz, R., Scarlata, C., Sluiter, J., Templeton, D., Rawat, I., Ranjith Kumar, R., Mutanda, T., Bux, F., Olguı, E. J., Nauha, E. K., Alopaeus, V., Mussgnug, J. H., Klassen, V., Schl??ter, a., Kruse, O., Lam, M. K., and Lee, K. T. (2011) Dual role of microalgae: Phycoremediation of domestic wastewater and biomass production for sustainable biofuels production. Chemical Engineering Journal, **22**(1), 3411–3424. [online] http://dx.doi.org/10.1016/j.cej.2012.03.013 (Accessed July 10, 2014).

Liang, Z., Liu, Y., Ge, F., Xu, Y., Tao, N., Peng, F., and Wong, M. (2013) Efficiency assessment and pH effect in removing nitrogen and phosphorus by algae-bacteria combined system of Chlorella vulgaris and Bacillus licheniformis. Chemosphere, **92**(10), 1383–9. [online] http://www.ncbi.nlm.nih.gov/pubmed/23751125 (Accessed July 17, 2014).

Miao, M., Yao, X., Shu, L., Yan, Y., Wang, Z., Li, N., Cui, X., Lin, Y., and Kong, Q. (2016) Mixotrophic growth and biochemical analysis of Chlorella vulgaris cultivated with synthetic domestic wastewater. International Biodeterioration & Biodegradation, **In press**, 1–6.

Posadas, E., Bochon, S., Coca, M., García-González, M. C., García-Encina, P. a., and Muñoz, R. (2014) Microalgae-based agro-industrial wastewater treatment: a preliminary screening of biodegradability. Journal of Applied Phycology. [online] http://link.springer.com/10.1007/s10811-014-0263-0 (Accessed July 17, 2014).

Ruiz-Martinez, a, Martin Garcia, N., Romero, I., Seco, a, and Ferrer, J. (2012) Microalgae cultivation in wastewater: nutrient removal from anaerobic membrane bioreactor effluent. Bioresource technology, **126**, 247–53. [online] http://www.ncbi.nlm.nih.gov/pubmed/23073115 (Accessed July 17, 2014).

Zamalloa, C., Boon, N., Verstraete, W., Wu, Z., Zhu, Y., Huang, W., Zhang, C., Li, T., Zhang, Y., Li, A., Wang, M., Kuo-Dahab, W. C., Dolan, S., Park, C., Wang, C., Yu, X., Lv, H., and Yang, J. (2013) Nitrogen and phosphorus removal from municipal wastewater by the green alga Chlorella sp . Bioresource technology, **34**(April), 421–425. [online] http://www.ncbi.nlm.nih.gov/pubmed/24384320 (Accessed July 10, 2014).