

Article

# Effect of the Oxidative Phosphorylation Uncoupler *Para*-Nitrophenol on the Activated Sludge Community Structure and Performance of a Submerged Membrane Bioreactor

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## Supplementary Material

**Table S1.** Analysis of Variance (ANOVA) of the relative abundances of activated sludge taxa at class-phylum level during operation of an MBR system prior to and after *para*-nitrophenol addition.

|                              | day 27           | day 31            | day 32           | day 55           |
|------------------------------|------------------|-------------------|------------------|------------------|
| <i>Bacteroidetes</i>         | 12.20 ± 0.85 (a) | 22.52 ± 0.74 (b)  | 28.71 ± 0.31 (c) | 28.55 ± 0.44 (c) |
| <i>Actinobacteria</i>        | 32.21 ± 1.19 (c) | 18.36 ± 0.65 (b)  | 12.66 ± 0.30 (a) | 19.68 ± 0.53 (b) |
| <i>Betaproteobacteria</i>    | 18.45 ± 0.61 (b) | 14.10 ± 0.59 (a)  | 14.44 ± 0.16 (a) | 18.51 ± 0.23 (b) |
| <i>Planctomycetes</i>        | 10.96 ± 0.68 (b) | 10.27 ± 0.87 (ab) | 11.08 ± 0.09 (b) | 8.91 ± 0.25 (a)  |
| <i>Alphaproteobacteria</i>   | 11.10 ± 0.52 (b) | 12.67 ± 0.69 (c)  | 8.28 ± 0.21 (a)  | 8.63 ± 0.08 (a)  |
| <i>Chloroflexi</i>           | 5.22 ± 0.43 (b)  | 6.48 ± 0.29 (c)   | 5.53 ± 0.14 (b)  | 3.43 ± 0.02 (a)  |
| <i>Gammaproteobacteria</i>   | 2.45 ± 0.18 (a)  | 6.40 ± 0.14 (c)   | 8.18 ± 0.09 (d)  | 3.68 ± 0.05 (b)  |
| <i>Deltaproteobacteria</i>   | 4.56 ± 0.12 (a)  | 4.10 ± 0.28 (a)   | 4.20 ± 0.06 (a)  | 4.64 ± 0.16 (a)  |
| <i>Firmicutes</i>            | 0.79 ± 0.06 (a)  | 2.96 ± 0.12 (b)   | 4.12 ± 0.07 (c)  | 1.06 ± 0.07 (a)  |
| <i>Proteobacteria-others</i> | 0.66 ± 0.04 (a)  | 0.90 ± 0.03 (b)   | 1.30 ± 0.01 (c)  | 0.84 ± 0.06 (b)  |
| <i>Verrucomicrobia</i>       | 0.49 ± 0.06 (a)  | 0.51 ± 0.07 (a)   | 0.46 ± 0.02 (a)  | 0.64 ± 0.05 (a)  |
| <i>Acidobacteria</i>         | 0.26 ± 0.02 (c)  | 0.13 ± 0.01 (a)   | 0.20 ± 0.01 (b)  | 0.58 ± 0.02 (d)  |
| <i>Cyanobacteria</i>         | 0.15 ± 0.01 (a)  | 0.20 ± 0.01 (b)   | 0.42 ± 0.01 (c)  | 0.23 ± 0.02 (b)  |
| <i>Deinococcus-Thermus</i>   | 0.23 ± 0.01 (c)  | 0.13 ± 0.00 (b)   | 0.09 ± 0.01 (a)  | 0.29 ± 0.01 (d)  |
| <i>Ignavibacteriae</i>       | 0.11 ± 0.01 (a)  | 0.11 ± 0.01 (a)   | 0.13 ± 0.01 (a)  | 0.13 ± 0.01 (a)  |
| <i>Ca. Saccharibacteria</i>  | 0.07 ± 0.03 (a)  | 0.01 ± 0.00 (a)   | 0.02 ± 0.01 (a)  | 0.07 ± 0.01 (a)  |
| <i>Gemmatimonadetes</i>      | 0.03 ± 0.01 (a)  | 0.05 ± 0.00 (ab)  | 0.06 ± 0.01 (b)  | 0.04 ± 0.01 (ab) |
| <i>Chlamydiae</i>            | 0.03 ± 0.01 (ab) | 0.05 ± 0.02 (ab)  | 0.07 ± 0.00 (b)  | 0.02 ± 0.00 (a)  |
| <i>Spirochaetes</i>          | 0.02 ± 0.00 (ab) | 0.02 ± 0.00 (a)   | 0.04 ± 0.01 (bc) | 0.05 ± 0.01 (c)  |
| <i>Epsilonproteobacteria</i> | 0.01 ± 0.00 (a)  | 0.02 ± 0.00 (ab)  | 0.02 ± 0.00 (b)  | 0.01 ± 0.00 (a)  |
| <i>Fibrobacteres</i>         | 0.00 ± 0.00 (a)  | 0.00 ± 0.00 (ab)  | 0.00 ± 0.00 (b)  | 0.02 ± 0.00 (a)  |

\*, Letters in common within rows indicate no statistically significant differences in the relative abundance of the individual taxa ( $p < 0.05$ , in Duncan's tests).

**Table S2.** Analysis of Variance (ANOVA) of the relative abundances of activated sludge taxa at genus level during operation of an MBR system prior to and after *para*-nitrophenol addition.

|                          | day 27           | day 31           | day 32           | day 55           |
|--------------------------|------------------|------------------|------------------|------------------|
| <i>Arthrobacter</i>      | 17.75 ± 1.48 (c) | 1.84 ± 0.05 (a)  | 1.21 ± 0.01 (a)  | 9.92 ± 0.58 (b)  |
| <i>Pirellula</i>         | 5.13 ± 0.32 (a)  | 5.61 ± 0.45 (ab) | 6.47 ± 0.05 (b)  | 6.06 ± 0.07 (ab) |
| <i>Sphaerotilus</i>      | 7.38 ± 1.02 (a)  | 11.03 ± 0.58 (b) | 10.67 ± 0.14 (b) | 11.87 ± 0.11 (b) |
| <i>Nakamurella</i>       | 4.48 ± 0.24 (b)  | 5.08 ± 0.62 (b)  | 3.02 ± 0.10 (a)  | 3.10 ± 0.19 (a)  |
| <i>Planctomyces</i>      | 3.28 ± 0.19 (b)  | 4.10 ± 0.44 (b)  | 4.11 ± 0.14 (b)  | 2.30 ± 0.18 (a)  |
| <i>Tetrasphaera</i>      | 3.58 ± 0.19 (c)  | 1.47 ± 0.12 (b)  | 0.81 ± 0.03 (a)  | 1.66 ± 0.01 (b)  |
| <i>Terrimonas</i>        | 2.99 ± 0.08 (a)  | 5.02 ± 0.10 (c)  | 5.58 ± 0.04 (d)  | 3.89 ± 0.08 (b)  |
| <i>Haliscomenobacter</i> | 3.26 ± 0.38 (a)  | 6.62 ± 0.24 (b)  | 7.49 ± 0.05 (c)  | 7.81 ± 0.20 (c)  |
| <i>Singulisphaera</i>    | 2.21 ± 0.21 (b)  | 0.27 ± 0.03 (a)  | 0.22 ± 0.01 (a)  | 0.26 ± 0.01 (a)  |
| <i>Caldilinea</i>        | 1.73 ± 0.08 (a)  | 2.38 ± 0.10 (b)  | 2.32 ± 0.03 (b)  | 1.51 ± 0.05 (a)  |
| <i>Paracoccus</i>        | 2.00 ± 0.12 (c)  | 2.09 ± 0.10 (c)  | 1.39 ± 0.07 (b)  | 1.02 ± 0.09 (a)  |
| <i>Bellilinea</i>        | 1.42 ± 0.17 (b)  | 1.99 ± 0.12 (c)  | 1.29 ± 0.03 (b)  | 0.41 ± 0.00 (a)  |
| <i>Hyphomicrobium</i>    | 1.29 ± 0.11 (b)  | 1.79 ± 0.12 (c)  | 1.02 ± 0.03 (ab) | 0.80 ± 0.04 (a)  |
| <i>Ferruginibacter</i>   | 1.40 ± 0.06 (a)  | 1.27 ± 0.08 (a)  | 1.40 ± 0.04 (a)  | 4.32 ± 0.13 (b)  |
| <i>Sporichthya</i>       | 1.19 ± 0.06 (a)  | 4.48 ± 0.21 (d)  | 3.22 ± 0.17 (c)  | 1.91 ± 0.07 (b)  |
| <i>Rhodobacter</i>       | 1.37 ± 0.08 (b)  | 1.96 ± 0.18 (c)  | 1.19 ± 0.07 (b)  | 0.54 ± 0.05 (a)  |
| <i>Nannocystis</i>       | 1.27 ± 0.06 (b)  | 1.90 ± 0.19 (c)  | 1.89 ± 0.04 (c)  | 0.85 ± 0.04 (a)  |
| <i>Clostridium</i>       | 0.67 ± 0.06 (a)  | 2.72 ± 0.11 (b)  | 3.85 ± 0.08 (c)  | 0.88 ± 0.06 (a)  |
| <i>Cytophaga</i>         | 0.87 ± 0.10 (a)  | 3.17 ± 0.25 (b)  | 4.85 ± 0.13 (c)  | 2.81 ± 0.16 (b)  |
| <i>Pseudomonas</i>       | 0.74 ± 0.04 (a)  | 2.06 ± 0.08 (b)  | 3.31 ± 0.05 (c)  | 2.20 ± 0.04 (b)  |
| <i>Lewinella</i>         | 0.80 ± 0.08 (a)  | 1.50 ± 0.09 (b)  | 1.57 ± 0.03 (b)  | 1.47 ± 0.06 (b)  |
| <i>Acinetobacter</i>     | 0.06 ± 0.01 (a)  | 1.59 ± 0.06 (b)  | 1.58 ± 0.01 (b)  | 0.10 ± 0.01 (a)  |
| <i>Fluviicola</i>        | 0.26 ± 0.03 (a)  | 0.86 ± 0.06 (b)  | 1.75 ± 0.04 (c)  | 0.78 ± 0.03 (b)  |
| <i>Pedobacter</i>        | 0.20 ± 0.03 (a)  | 0.31 ± 0.02 (a)  | 0.36 ± 0.01 (a)  | 2.35 ± 0.26 (b)  |
| <i>Archangium</i>        | 0.76 ± 0.01 (b)  | 0.14 ± 0.01 (a)  | 0.13 ± 0.01 (a)  | 1.71 ± 0.07 (c)  |
| <i>Chitinophaga</i>      | 0.54 ± 0.05 (a)  | 0.73 ± 0.02 (b)  | 0.89 ± 0.04 (c)  | 1.56 ± 0.07 (d)  |
| <i>Rickettsia</i>        | 0.72 ± 0.20 (b)  | 0.02 ± 0.01 (a)  | 0.05 ± 0.01 (a)  | 1.64 ± 0.21 (c)  |
| Others                   | 32.66 ± 0.12 (c) | 27.98 ± 0.26 (b) | 28.35 ± 0.27 (b) | 26.31 ± 0.46 (a) |

\*, Letters in common within rows indicate no statistically significant differences in the relative abundance of the individual taxa ( $p < 0.05$ , in Duncan's tests).