EUROPEAN COOPERATION IN SCIENCE AND TECHNOLOGY

CYANOCOST – ES 1105 Action

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Cyanobacterial blooms and toxins in water resources: Occurrence, impacts and management.

Short Term Scientific Mission (STSM)

Title:Degradation of cyanobacterial metabolites (taste and odor compounds) using Advanced Oxidation Processes (AOPs)

Researcher

Dr Christophoros Christophoridis

Post-Doc Researcher

NCSR Demokritos Greece

Group Leader: Dr A. Hiskia

Studied Environmental Chemistry, specializing in Analytical Techniques and water treatment technologies. Worked as a Post-Doc in Munich, TUM and Athens (University & NCSR Demokritos)

Host Organization

Departament d'Enginyeria Química

Facultat de Química

Universitat de Barcelona

Martí i Franquès, 1, 6a- planta

08028 Barcelona

Professor Santi Esplugas

santi.esplugas@ub.edu

Objectives

- The evaluation of selected taste and odor compound removal using advanced oxidation processes.
- The optimization of working conditions of the reactors for the maximum degradation of target compounds and their transformation by-products.
- The determination and structure elucidation of transformation by-products using SPME-GC-MS, LC-MS

Methodology

- Taste and odour compounds: cyanobacterial metaboltes (Methylisoborneol-MIB, Geosmin-GSM, β-cyclocitral, 2-isopropyl-3-methoxypyrazine) and other anthropogenic compounds (Trichloroanisole-TCA, Tribromoanisole-TBA)
- Batch and continuous flow ozonation experiments
  - Influence of pH (4-9), temperature, DOM and ozone concentration were studied, as well as OH radical scavengers and simulated surface water were tested
- UV-C/H_2O_2 batch experiments
  - Influence of pH, H_2O_2 concentration and study of direct photolysis
- GC-MS and GC-MS/MS were employed for the identification of the transformation products. For 2-isopropyl-3-methoxypyrazine and TCA, transformation products were also evaluated using LC-HRMS (Orbitrap).

Results

- The extent of the target compounds' degradation, was found to be related to pH, applied ozone concentration and the initial concentration of each target compound. Higher ozone concentration leads to increased degradation rates (figure 1), while at higher pH values, the degradation of the compounds is promoted.
- Experiments in the presence and absence of OH radical scavenger (t-BuOH) have showed that at increased pH, higher degradation rates can be attributed to the production of OH radicals
- Degradation curves were extracted for all target compounds and the constants of second order kinetics of the degradation in the first 3 minutes of reaction were calculated, in combination to the ozone decay profile, which was measured using a dissolved ozone sensor.
- Continuous ozone flow experiments, using simulated lake water and a mixture of compounds provided information on the minimum ozone dose necessary for complete amelioration of each compound.
- Selected UV/peroxide experiments, showed that the production of OH radicals caused a complete degradation of the compounds in smaller time frames than ozonation. At pH value of 6.8 the degradation of the compounds is most effective, although no significant changes were observed at pH ranges of 6-8.
- Various transformation products were identified (7 for MIB, 4 for GSM, 3 for Pyr)

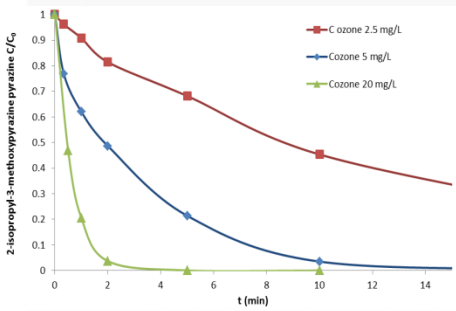
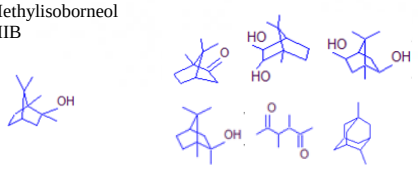


Figure 1. Influence of ozone concentration on the degradation of 2-isopropyl-3-methoxypyrazine using ozonation. Co pyr = 1 mg/L, pH=5.8

Initial Compound
Methylisoborneol
MIB

Transformation Product



Highlights

- An analytical method for the simultaneous determination of taste and odor compounds was developed using SPME-GC/MS.
- Ozone treatment successfully degraded all compounds under 45 minutes of reaction
- pH and ozone concentration were the main factors affecting ozonation
- Kinetic parameters were calculated for both ozonation and UV/peroxide treatment
- More than 4 transformation products were identified for each compound.

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