CYANOCOST – ES 1105 Action

EUROPEAN COOPERATION IN SCIENCE AND TECHNOLOGY

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

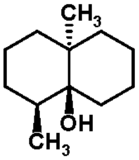
www.cyanocost.com

Short Term Scientific Mission (STSM)

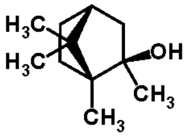
Effects of different degrading species on 2-methylisoborneol and geosmin during γ-radiolysis of water

Objectives

Experiments were conducted in order to determine the efficiency of different oxidising and reducing species (OH·, HOO·, O_2^-, e_{aq}^-, H·) in the degradation of cyanobacterial taste and odour compounds 2-methylisoborneol (MIB) and geosmin (GSM). Furthermore, the degradation products of certain degrading species were investigated in order to understand the different degrading pathways. This will facilitate better understanding of oxidising and reducing process in other radical-producing processes.



geosmin



2-methylisoborneol

Methodology

A solution (10 mL) containing either 1 mg L^{-1} of MIB or GSM was irradiated with a total dose of 231 Gy (= 60 min irradiation at a dose rate of 0.064 Gy s^{-1}) with aliquots (0.1 mL) taken at regular intervals. Samples were then diluted and analysed by head space (HS) solid phase micro extraction (HS-SPME) followed by gas chromatography coupled with mass spectrometric analysis (GC-MS). Different scavengers were used to manipulate the system in order to ensure the presence of only one degrading species during an experiment; all scavengers were applied at a concentration of 2.0 x 10^{-2} M and all experiments were carried out in duplicate. For the determination of degradation product, solutions (10 mL) containing 10 mg L^{-1} of either MIB or GSM were irradiated with a doses of 0, 7.7, 19.25, and 38.5 Gy, respectively. Following irradiation liquid-liquid extraction with dichloromethane was performed. Samples were then concentrated by nitrogen flow and analysed by GC-MS in scan mode. The degradation products for the oxidative degradation pathway (by OH·), reductive pathway (by e_{aq}^-), the degradation by super oxide and hydroperoxyl radical, as well as an uncontrolled system (no scavengers used) were investigated.

Results

A total of 18 degradation products have been identified for MIB and 32 for geosmin. It has been shown that the oxidative pathway (via OH·) and the reductive pathway (via e_{aq}^-) differ in the degradation of MIB, the oxidative pathway proceeds via the production of camphor, while the reducing pathway proceeds via the production of fenchyl alcohols. As for geosmin, the oxidative appears to proceed via an initial ringopening followed by a second ring opening, arriving at a linear structure. This process appear similar in both the oxidative and reductive degradation pathway.

Highlights

- Different degrading species display differing degradation efficiencies.
- Efficiencies for both compounds follow (most to least efficient): OH·>H·> e_{aq}^-> HOO·/ O_2^-
- Oxidation of MIB follows camphor pathway, reduction of MIB fenchyl alcohol pathway
- The degradation of GSM proceeds via ring openings to linear structures.

Researcher

Dr. Carlos J. Pestana,

School of Pharmacy and Life Science, Robert Gordon University, Aberdeen, UK

Group Leader Prof. Linda A. Lawton

Short Bio:
2014-current Robert Gordon University
2014 University of New South Wales, Sydney, Australia
2012-14 South Australian Water Corporation, Adelaide, Australia
2008-12 PhD Robert Gordon University

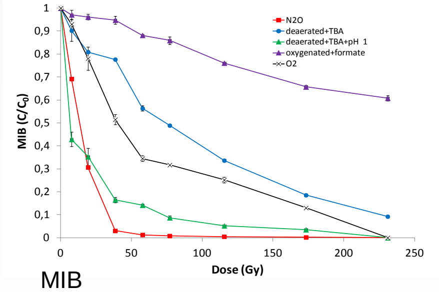
Host Organization

National Centre for Scientific Research Demokritos, Athens, Greece

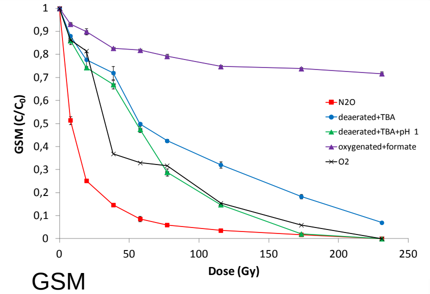
Institute of Nanoscience and Nanotechnology

Host Supervisor: Dr. Anastasia Hiskia

Collaborator: Dr. Trintafyllos Kaloudis (EYDAP, Athens, Greece)



MIB



GSM

COST is supported by the EU RTD Framework Programme

ESF provides the COST Office through a European Commission contract