WaterTOP: Taste and Odor in early diagnosis of source and drinking Water Problems

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Chairs, WaterTOP CA18225

WaterTOP Meeting
25-28 October 2021
Porto, Portugal

www.watertopnet.eu
Water T&O Workshop, 10-12 May 2017, Istanbul University

[Image of a group photo with labels:
- Chris Avagianos
- Reyhan Akcaalan
- Tri
- Latife Koker
- Zuhal Tunc
- Meric Albay (Taking the photo)]
The changing nature of science

The nature of science has changed. It has become more interconnected, interdisciplinary, collaborative and data-intensive. Collaboration has become critical to solving complex problems.

COST creates spaces where scientists are in the driving seat (bottom-up) and ideas can grow through a flexible and open approach. By enabling researchers from academia, industry and the public and private sector to work together in open networks that transcend borders, COST helps to advance science, stimulates knowledge sharing and pools resources.

National governments make a real difference by ensuring that research cooperation optimises national investments in research and technology and unlocks thereby the full potential of science.
COST Actions

- Pan-European networks.
- Near-neighboring countries, International partners
- Scientists, researchers, industry, policy makers, stakeholders.
- Advancement of science and technology.
- Increase capacities and capabilities.
- Scientific, research, societal, economic impacts.
- Support for Early Career Investigators (ECIs).
- Support for Inclusiveness Target Countries (ITCs).
- Inclusive, participative, open, flexible.

COST Tools:
- Training Schools
- Workshops
- Short-term Scientific Missions (STSMs)
- Conferences

Products-outcomes:
- Publications
- Tools
- Guidelines, newsletters
- Publicly available
Water is tasteless and odorless!?

Why was WaterTOP funded?
Drinking water fact:
T&O is the most frequent source of consumer complaints

A plethora of T&O can occur at various stages of drinking water production

- **Lakes (e.g. plankton metabolites and degradation products)**
  - Geosmin, MIB, α- and β-ionones, β-cyclocitral, pyrazines, sulfurous compounds aldehydes, amines (earthy, musty, fishy, swampy etc odors)

- **Water treatment**
  - Chlorinated compounds, chloramines, degradation products etc

- **Distribution network**
  - Trichloroanisole, compounds migrating from contact with materials

- **Household network**
  - Plasticizers, fuels (BTEX), industrial solvents etc etc
Which compounds contribute to water T&O?

### Examples of Threshold Odor Concentrations (TOC)

<table>
<thead>
<tr>
<th>Compound</th>
<th>Mean Odor Threshold in water (μg/L)</th>
<th>Descriptor</th>
</tr>
</thead>
<tbody>
<tr>
<td>geosmin</td>
<td>0.004</td>
<td>earthy</td>
</tr>
<tr>
<td>2-MIB</td>
<td>0.015</td>
<td>musty</td>
</tr>
<tr>
<td>2-Isobutyl-3-methoxypyrazine</td>
<td>0.0001</td>
<td>stale, musty</td>
</tr>
<tr>
<td>2,4,6 TCA</td>
<td>0.0009</td>
<td>musty, earthy</td>
</tr>
<tr>
<td>naphthalene</td>
<td>6</td>
<td>mothballs</td>
</tr>
<tr>
<td>chloroform</td>
<td>30000</td>
<td>chemical, antiseptic</td>
</tr>
<tr>
<td>b-cyclocitrinal</td>
<td>19</td>
<td>tobacco, woody</td>
</tr>
<tr>
<td>dimethyl trisulfide</td>
<td>0.010</td>
<td>septic</td>
</tr>
<tr>
<td>b-ionone</td>
<td>0.007</td>
<td>violets</td>
</tr>
</tbody>
</table>

Young et al. (1996), Water Research, 30(2), 331-340
Cotsaris et al. (1995), WST, 31(11), 251-258.
Examples of water T&O

Surface Water Reservoirs
Algal metabolites

- Geosmin (earthy)
- 2-Methylisoborneol (musty)
- Trimethylamine (fishy)
- Dimethyl trisulfide (septic)

Water treatment Chlorination products

- Trichloramine (swimming pool)
- 2-Chlorophenol (chemical)
- 2,4,6-Trichlorophenol (medicinal)
- 2,6-Dibromophenol (medicinal)

Distribution network biofilm activity, materials in contact

- 2,4,6-Trichloroanisole (musty)
- Naphthalene (mothballs)
- Benzo[1,2-c:4,5-c']thiazole (plastic)
- BHT (plastic)
Sensory analysis

- Descriptive and intensity tests
  - Flavor Profile Analysis
  - TON/TFN
  - ...

Discriminating tests

- Triangle tests
- Paired comparisons
- ...

Methods must be suitable for the intended use.
Sectors 1, 3, 4, 6 of the TOW may indicate cyanobacterial T&O.

Analysis of water T&O

FPA
sensory

GC-MS
chemical

GC-O
hybrid

Chemical analysis (GC-MS, GCxGC-MS, GC-HRMS etc)

Mass spectrum of geosmin (NIST Webbook)

Liquid-liquid Extraction, LLE
Solid Phase Extraction, SPE
Static Headspace Extraction
Dynamic Headspace (Purge & Trap)

Closed-Loop Stripping Analysis (CLSA)
Stir Bar Sorptive Extraction (SBSE)
Solid Phase Micro-extraction (SPME)

 Extraction methods for water T&O
Risk assessment – Risk Management

- Are water T&O compounds toxic at drinking water relevant concentrations?
- Any modes of bioactivity?
- Ecological and environmental impacts?
- Early warnings for other serious water quality problems? (e.g. geosmin/MIB as early warning for cyanobacterial toxins?)
- Databases – lists of water T&O compounds?
- Risk communication to consumers?
- How can water T&O be implemented in Water Safety Plans?
**The challenge:** Concentrations of water T&O must be reduced to **levels below the OTCs.**

- Coagulation, flocculation, sedimentation and filtration are generally ineffective.
- GAC/PAC effectiveness may be limited by competition with NOM (Newcombe et al., 2002).
- Common disinfectants and oxidants (e.g. Cl₂, ClO₂, KMnO₄) may not be effective, ozone is more efficient (Peter & von Gunten, 2007, Bruchet & Duguet, 2004).

**Advanced Oxidation Processes (AOP)** based on formation of **highly reactive radicals and oxygen species (ROS)** are a promising alternative.
WaterTOP (CA18225)
Taste and Odor in early diagnosis of source and drinking Water Problems
2019-2023

Albania
Austria
Bosnia and Herzegovina
Bulgaria
Croatia
Cyprus
Czech Republic
Denmark
Estonia
Finland
France
Germany
Greece
Hungary
Ireland
Israel
Italy
Latvia
Lithuania
Malta
Netherlands
North Macedonia
Poland
Portugal
Romania
Serbia
Spain
Sweden
Switzerland
Turkey
United Kingdom
United States
Total: 33

NNC/IPC:
Russian Federation
Canada
Australia
United States

WaterTOP MC meeting, 28/8/2019, Brussels

www.watertopnet.eu
Core Group (CG+) and Working Groups (WG)

**WG Leaders:**
- **WG1:** Ricard Devesa
- **WG2:** Martin Steinhaus
- **WG3:** Emanuela Testai
- **WG4:** Anastasia Hiskia

**Chairs:** Tri Kaloudis, Reyhan Akcaalan

**Grant Holder:** Theodoros Triantis

**Communications manager:** Galina Dimova

**STSM managers:** Popi Karaolia, Latife Koker, Kristel Panksep

**ITC Conference manager:** Radoslav Tonev

**CG+:** Rita Lado and Maura Manganelli

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**WG1**
Advances in sensory analysis
- FPA, Water T&O Wheel, consumer acceptability, sensors

**WG2**
Advances in chemical analysis
- GC-(HR)MS/MS, GCxGC, GC-O, SIDA-MS, SPME, SBSE, CLSA

**WG3**
Risk assessment
- Bioactivity, toxicity, health & ecological impacts, Compound lists, Water Safety Plans

**WG4**
Advances in water treatment
- UV/Cl₂, UV/H₂O₂, UV/O₃, TPs, GAC/PAC

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Dissemination-Exploitation-Capacity building
WaterTOP Activities

1st WaterTOP CG Meeting, Istanbul University, 13-14 Feb 2020
Organizers: Reyhan Akcaalan, Meric Albay

Work and Budget Plan for 2nd Period (1 May 2020 - 30 Apr 2021)

Plan included among others:
- 1 Training School on Chemical Analysis in Freising, TUM (Martin Steinhaus)
- 1 Training School on AOPs for water T&O in Athens, NCSR Demokritos (Anastasia Hiskia)
- 1 Training School on basics of Sensory analysis & GC-MS in Athens, EYDAP SA (Tri Kaloudis)
- STSMs

Activities were cancelled till August 2021, due to the pandemic
Training School: Introduction to Water Sensory Testing
13 March 2020, Barcelona
Organizer: Ricard Devesa

- Originally planned for 60 trainees
- Combined with WG and MC meeting
- Due to the outbreak of the pandemic, only 3 trainees participated.
Editorial Meeting, 27-30 Sep 2021, Nafplion, Greece
Organizer: Theodoros Triantis

- Preparation of a “perspectives” paper on water T&O for Chemical Engineering Journal Advances.
- Translation of the Taste & Odor Wheel (TOW) (R. Devesa)
- Virtual presentations on Water Treatment (A. Hiskia), Geosmin & MIB in Turkey (R. Akcaalan), Citizen Science (T. Kaloudis).
Translation of the Taste & Odor Wheel (TOW), (R. Devesa)
Proposal for a WaterTOP citizen science project (T. Kaloudis).
Virtual presentations on sensory analysis (A. Dietrich), water treatment (A. Zamyadi), historical development of TOW (R. Devesa).
On-going work: TOW translation and dissemination
Coordinator: Ricard Devesa

- Translate TOW in EU, COST countries and NNC languages.

Future development:
- Development of TOW as a web-tool (translations, links to information).
- TOW as a mobile app.
On-going work: WaterTOP Citizen Science Project
Proposer: Tri Kaloudis

Involving citizens in sensory evaluation of water.

The proposal can be downloaded here: Link
Products and Outcomes

Special Issue in Chemical Engineering Journal Advances (CEJA)

Chemical Engineering Journal Advances

Publishing options: Open Access

Guide for authors  Track your paper

ISSN: 2666-8211

Editor-in-Chief  Editorial board

Bingcai Pan, Ph.D.

Chemical Engineering Journal Advances, a partner title to the highly-regarded Chemical Engineering Journal, is a new online only, open access, peer reviewed journal.
CEJA: Invitation to submit articles

Special Issue on Water taste and odour (T&O): challenges, gaps and solutions
© July 2021

Summary


The access to safe & clean drinking water (DW) is recognized by the United Nations as an elementary human right to protect human health. A number of taste and odour (T&O) substances of natural or anthropogenic origin (e.g. bacteria/algae metabolites, industrial pollutants) can occur in tap water as result of contamination at the source, during treatment or in distribution networks. As result, the unpleasant T&O of DW can lead to a great mistrust in tap water by consumers and a consequent higher consumption of bottled water.

Although the scientific community has been widely addressing the environmental concerns about contaminants of emerging concern, T&O substances have been receiving much less attention. In this regard, water treatment for removal of T&O needs attention in order to provide solutions that are able to achieve extremely low concentrations after treatment, otherwise T&O would be sensed by consumers. Adsorption, chemical disinfectants and advanced oxidation processes have been studied in the last years for removal of T&O substances. The knowledge on this topic is still limited and other related research gaps include the generation of transformation products, the sensory properties of treated water, and the potential use of T&O substances as indicators of point sources of contamination of other potentially harmful substances.

We warmly invite research and review papers on all aspects of water T&O in aquatic systems such as source waters, drinking water, wastewater and aquaculture. Special focus is given to detection and identification of natural & anthropogenic T&O compounds with sensory panels and advanced analytical techniques, assessment of risks and impacts, prevention - control measures and water treatment to remove T&O.

Important Dates

Submission opening on September 2020
Submission closing on 31st December 2021

Link to WaterTOP CEJA Special Issue
Published papers (acknowledging WaterTOP and COST)


Presentations:
(can be downloaded from “Products” page at www.watertopnet.eu )


Dietrich T&O Tartu 2021 Download

Nicolas Clercin – Tracking taste & odour producers and potential degraders in a drinking water supply reservoir. Tartu, 2021

Clercin 2021. Tracking T&O Producers and Potential Degraders Download

Arash Zamyadi – Investigating water treatment processes for removal of taste & odour compounds. Tartu, 2021

Arash Zamyadi watertop oct 2021 Download


Kaloudis Citizen Science Nafplion 2021 Download


Hiskia WaterTOP_Nafplio 2021 Download

Tri Kaloudis – Taste & Odor in early diagnosis of source and drinking water problems (WaterTOP). Brussels, 2019

Tri Kaloudis – WaterTOP kick-off Presentation Brussels 28_8_2019 Download
Publicized articles

WaterTOP message on World Water Day 2020

Taste and odour in water: early warnings of possible troubles?
WaterTOP featured in AlphaGalileo

Towards effective protection of water resources and human health – WaterTOP Featured in News Medical

WaterTOP Featured in “BULAQUA” of the Bulgarian Water Association

WaterTOP featured in CYANOnews

12-15 Nov 2019: Presentation of WaterTOP in 3rd Int. Water & Health Congress, Turkey

31 Oct-3 Nov 2019: Presentation of WaterTOP in ENVIROCHEM, Turkey
WaterTOP media

Website: www.watertopnet.eu

Facebook: @watertopcost

Twitter: @WaterTopCost

New YouTube Channel: Link
Acknowledgements

COST Science Officer, Dr. Deniz Karaca and COST Administrative Officer, Andrea Tortajada

Core Group+ and Management Committee members for their contributions.

Special thanks to Local Organizers of our meetings:
Reyhan Akcaalan, Meric Albay – Istanbul
Ricard Devesa – Barcelona
Theodoros Triantis – Nafplion
Kristel Panksep – Tartu
Rita Lado - Porto

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