HOW DO DIFFERENT SPECIES OF DISINFECTION BY-PRODUCTS COMPARE TO WATER QUALITY GUIDELINES?

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So, what is...

Chlorine

Drinking water is commonly treated with **chlorine** to ensure we have safe water to drink. It is an **important and critical** component in the treatment of drinking water.

DOC

dissolved organic carbon

A mixture of thousands of different **organic molecules** (mostly carbon) and comes from in-lake production or decomposed organic matter (such as leaf litter).

DBP

disinfection by-product

Chlorine **reacts** with DOC to form DBPs that range in abundance and toxicity. Currently, it is too difficult to regulate every DBP species.

We monitor & set guidelines for two DBP groups:

THM
trihalomethanes

- chloroform
- bromoform
- chlorodibromomethane
- dichlorobromomethane

HAA
haloacetic acids

HAA_1
- bromodichloroacetic acid
- chlorodibromoacetic acid
- tribromoacetic acid

HAA_2
- chloroacetic acid
- bromoacetic acid
- dichloroacetic acid

HAA_3
- trichloroacetic acid
- dibromoacetic acid
- bromochloroacetic acid

BUT the current guidelines for THM & HAA are confusing. Why?

It's like *cotton candy* and *jam*:

cotton candy

jam

both are considered 'sweets' but are different products

let's say we have a mixed box of cotton candy and jam and were asked to calculate how much there was

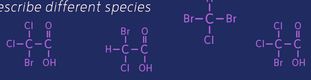
if you just weighed the box, you would have a total weight of the sweets **but** it would be skewed by how much jam is in the box as jam is *much heavier* than the cotton candy

alternatively, you could just count the **jars** of cotton candy and jam you have

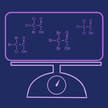
knowing how much cotton candy and jam are in a jar, you gain a better understanding of the 'total' sweets you have

(and you can compare it to DBPs):

THM and HAAs are both DBPs, but describe different species

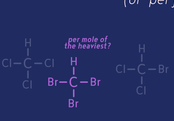


when we add chlorine to water with DOC, we form different species of THM and HAAs; each with differing molecular weights



current guidelines add up the total weights of each DBP species, ***regardless*** *of their individual molecular weight*

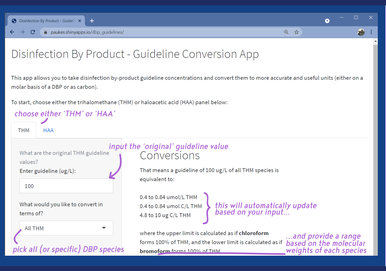
but we really should be calculating a total value on a molar basis (or 'per jar' basis)



So, how do guidelines compare to the range in individual species?

The guidelines are a 'boxed weight', so we created a tool to unpack this box and look at the different jars of sweets to see what we actually have.

Here, you can **convert guideline concentrations** to **molar units** for a customizable combination of DBP species

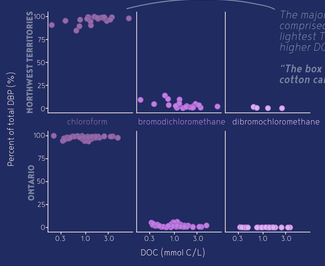


ACCESS IT HERE:
github.com/paukes/DBP_Guidelines

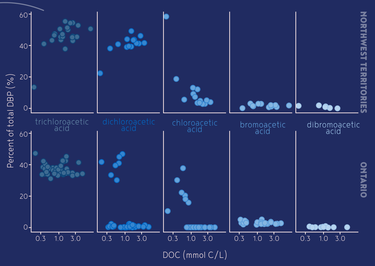
Let's take a look at how DBP is comprised of various species:

We sampled a number of Canadian boreal lakes (Ontario and Northwest Territories) just to see how different DOC mixtures affect the formation of THM and HAA species:

THMs are dominated by a **single species** across both locations



The majority of **HAA_5** is comprised of **two species**



Similar THM & HAA percentages between Ontario and the Northwest Territories, even though the climate & vegetation differ between sites

In untreated lake water, not only do we find **different abundances** of THM and HAA species, but we also find these **abundances vary with DOC** concentration, especially among HAA.

What about the toxicity of various DBP species?

Our expertise lies with understanding how a warming climate will alter DOC and DBP concentrations. In terms of health effects, others have found that:

- overall, there is a **lack of toxicological data** for DBP in humans[1]
- THM & HAA species **differ** in toxicity[1,2]
- more **problematic DBP species** than the ones currently regulated can be formed[1,2]
- how the water is treated can influence the amount of DBPs formed[3,4]

1) Richardson et al. 2007
doi: 10.1016/j.mrrev.200709.001
2) Plewa et al. 2017
doi:10.1016/j.jes.201704.014
3) Williams et al. 2019
doi:10.1016/j.scitotenv.2018.10.184
4) Huang et al. 2017
doi: 10.5942/jawwa.2017.109.0115

What do we take away from this?

- Can examine how guidelines relate to different THM & HAA species
- Accounting for DBP species may be more important in HAA than THM (where it is mostly chloroform)
- How do we combine what we know of DBP speciation, current guideline values, and relative toxicity?

If you'd like to continue the conversation, or if you have questions, feel free to reach out to paukes@wlu.ca

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