Sucralose – a new persistent pollutant in the environment?

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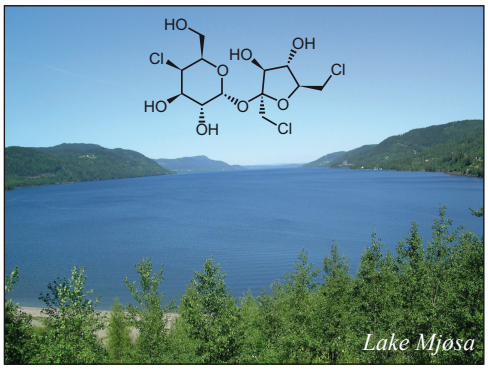
Introduction

Sucralose has been used as an artificial sweetener for nearly 30 years, and today the compound is approved as sweetener in more than 80 countries. Norway approved sucralose in June 2005, and the sweetener is now used in various low-calorie food and soft drinks and can also be obtained commercially as sugar substitute (Splenda) in food stores. The molecule is a tri-chlorinated disaccharide, which is 600 times sweeter than sucrose. The human excretion is not able to utilize the molecular energy, and more than 85 % is excreted unchanged while a minor fraction conjugates with glucuronic acid. The environmental lifetime in Norwegian waters is expected to be 5-10 years. Sucralose has a low human toxicity and it does not bio-accumulate. However, the environmental persistence is of concern due to the lack of knowledge on how sucralose interact with the aquatic environment. In order to access the fate of sucralose and the possible impact on the aquatic environment NILU has developed a new method for screening of sucralose in environmental samples.



Methodology

- Solid phase sample extraction
- Two-step clean-up of the sample extract
- Chemical analysis by high performance liquid chromatography (HPLC) combined with high resolution mass spectrometry (HRMS)

Sucralose properties

Sweetness compared with sucrose

- Cyklamat (E952): 25-30 times
- Acesulfam K (E950): 130-200 times
- Aspartam (E951): 200 times
- Sakkarin (E954) : 300 times
- Sucralose (E955): 500-600 times

ADI

- Cyklamat: 7 mg/kg body mass
- Acesulfam K: 9 mg/kg body mass
- Aspartam: 40 mg/kg body mass
- Sakkarin: 5 mg/kg body mass
- Sucralose: 15 mg/kg body mass

Are there any effects in the environment?

- Sucralose inhibits the transport of sucrose in sugar cane (Reinders et al. (2006) Plant Cell Environ 29:1871-1880)
- No other environmental effects known, but it should be noted that sucralose has at least one biological effect: Sweetness
- Several functions in the aquatic environment depend on taste, e.g., orientation, finding a mate, finding food. Will these functions be affected by sucralose?

What if sucralose?

- …is triggering undue feeding behaviour in, e.g., zooplakton?
- …impacts the carbon cycle?
- …affects signals between symbionts? (Zoosymbiont reacts on sugars from phytosymbiont in, e.g., corals.)
- …affects orientation in migrating salmonids?

Chemical analysis of beverages

Product	Sucralose mg/l
Soft drink 1	105
Soft drink 2	75
Soft drink 3	74
Soft drink 4	158
Soft drink 5	<lod
Squash 1	152*
Squash 2	113*
Tomatoketchup 1	86**
Water with taste 1	<0.003
Water with taste 2	<0.003
Water with taste 3	<0.003
Water with taste 4	<0.003

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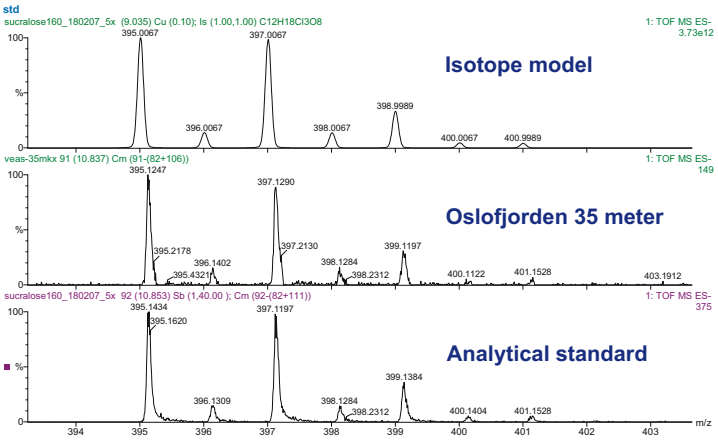
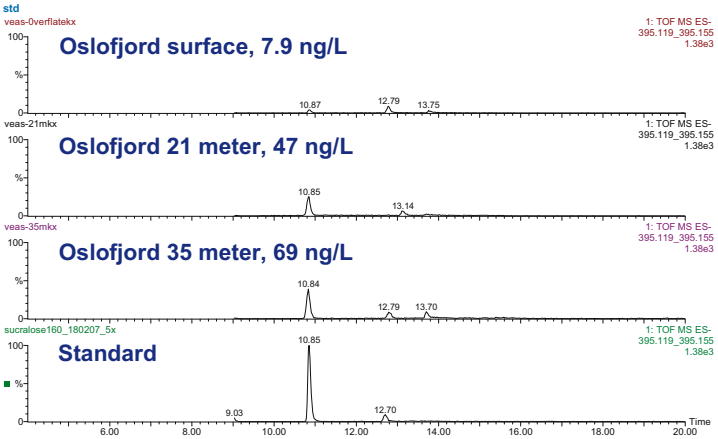
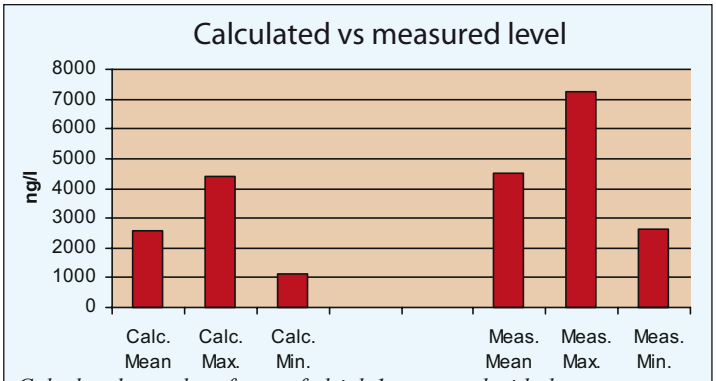
Mass Spectral Isotope Pattern



Extracted ion chromatogram (35 mDa)



(Comment: Nominal mass spec. is 1000 mDa)



Calculated sucralose from soft drink 1 compared with the measured VEAS total sucralose.

Conclusion

- According to 2002/657/EC the new analytical method provides high quality chemical analysis of soft drinks, sewage influent and effluent, and sewage sludge.
- Sucralose is unequivocal identified in STP influent and effluent at levels up to several mg/L.
- Sucralose is unequivocal identified in the recipients (Oslofjorden and Mjøsa).
- The sewage treatment plants are not able to remove sucralose from the wastewater.
- Due to the water accumulation potential, the fate and impact of sucralose in aquatic environments needs to be explored in future research.