19. Evaluation of Drinking Water Treatment Technologies for Removal of Endocrine Disrupting Compounds

Presenter

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Evaluation of Drinking Water Treatment Technologies for Removal of Endocrine Disrupting Compounds

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Endocrine disrupting compounds (EDCs) are exogenous agents that interfere with the synthesis, secretion, transport, binding, action, or elimination of natural hormones in the body that are responsible for the maintenance of homeostasis, reproduction, development, and/or behavior.

Many of the chemicals identified as potential endocrine disrupting compounds (EDCs) may be present in surface or ground waters used as drinking water sources due to their introduction from:

- Domestic and industrial sewage treatment systems.
- Wet-weather runoff.

Occurrence of EDCs in U.S. streams

Compound	Number of samples	Reporting limit µg/L	Freq. of detection %	Maximum conc. µg/L	Median detectable conc. µg/L
estradiol	70	0.005	10.0	0.093	0.009
ethynyl estradiol	70	0.005	5.7	0.273	0.094
testosterone	70	0.005	2.8	0.214	0.116
nonylphenol	85	0.50	50.6	40[a]	0.8[a]

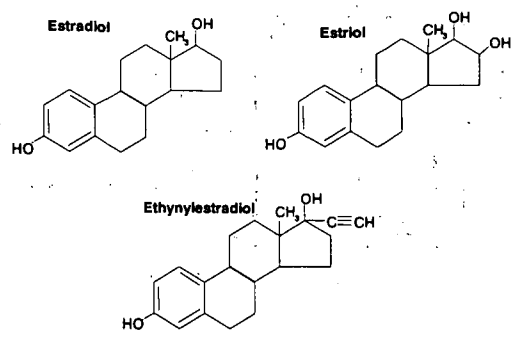
a: concentration estimated – reference standard from technical mixture

From: Environ. Sci. Technol. 36,1202 – 1211, 2002, Environ. Sci. Technol. 36,407 – 4006, 2002

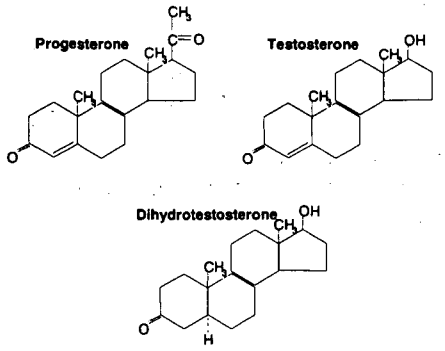
Basic strategies to decrease the potential risk of adverse health effects associated with the presence of EDCs in drinking water:

- Protect drinking water sources from contamination by EDCs.
- Remove EDCs, that may be present in source waters, during drinking water treatment.

Compounds to be evaluated



Compounds to be evaluated



Additional compounds to be evaluated in the future

4-nonylphenol (NP)

4-nonylphenol mono-ethoxylate (NP1EO)
4-nonylphenol diethoxylate (NP2EO)

4-octylphenol mono-ethoxylate (OP1EO)
4-octylphenol diethoxylate (OP2EO)

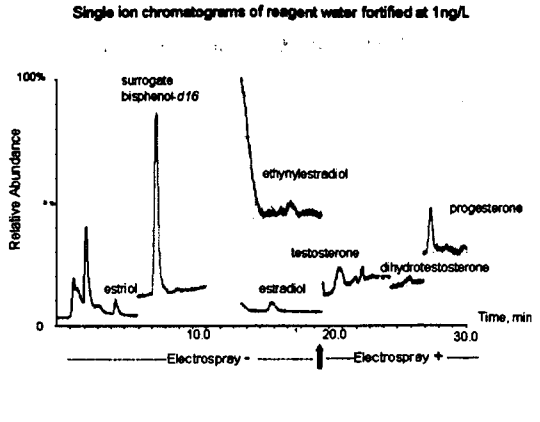
Technical approach

Develop analytical methods to identify and quantify the target compounds. The approach includes concentration by solid-phase extraction, followed by LC/MS.

Analytical method for steroid compounds

Solid phase extraction:
Baker C18 XF speed disks eluted with methanol

Quantitation:
Waters ZQ LC/MS, electrospray
Xterra C18 column
Single step gradient, 50 – 65% methanol in ammonium hydroxide in water
Single ion mode



Technical approach (cont.)

Evaluate the use of a reporter gene assay, the MVLN assay, to detect the presence/ removal of estrogenic activity. This assay uses a human breast cell line (MCF-7) which has been stably transfected with the firefly luciferase gene.

Technical approach (cont.)

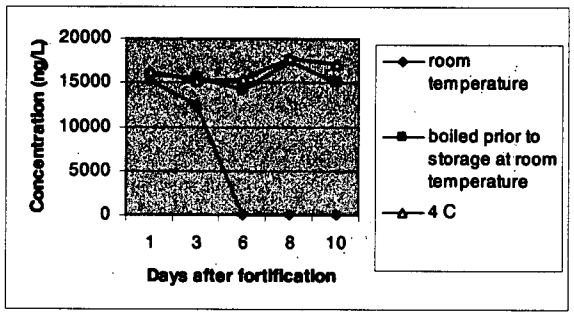
Conduct bench-scale evaluations of various drinking water treatment technologies, including granular activated carbon, nanofiltration, softening and conventional treatment.

Pilot-scale evaluations may be conducted on the treatment technologies that appear promising at bench-scale.

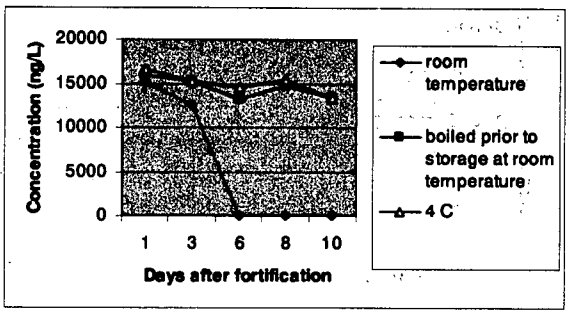
Granular activated carbon (GAC) isotherm studies

- Organic–free water buffered to pH 7 with phosphate buffer (0.005 M)
- Target compound added to buffer and mixed for approximately 4 days
- Solution added to isotherm bottles containing various amounts of GAC (100 X 200 mesh)
- After carbon reaches equilibrium, solution is pumped out through a 0.22 μm filter
- Initial and final concentration data used to determine adsorption capacity of GAC

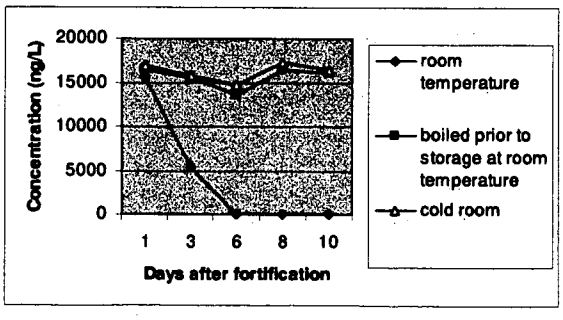
Stability of testosterone over time



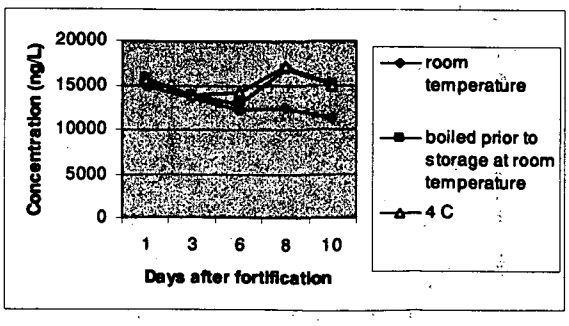
Stability of dihydrotestosterone over time



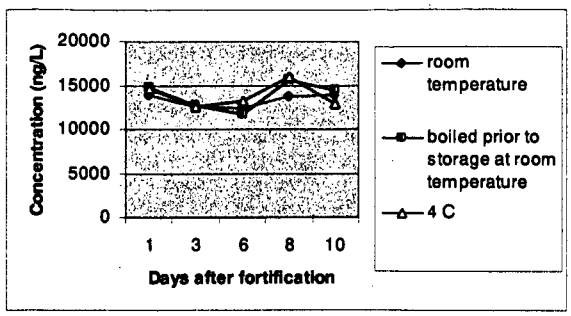
Stability of progesterone over time



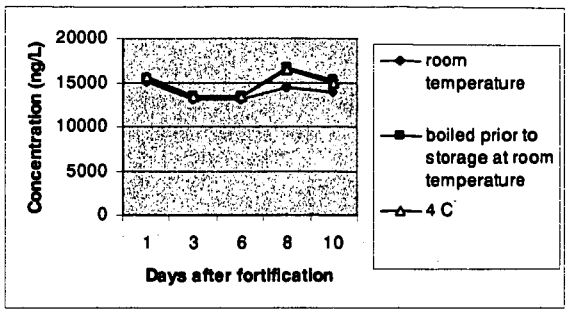
Stability of estradiol over time



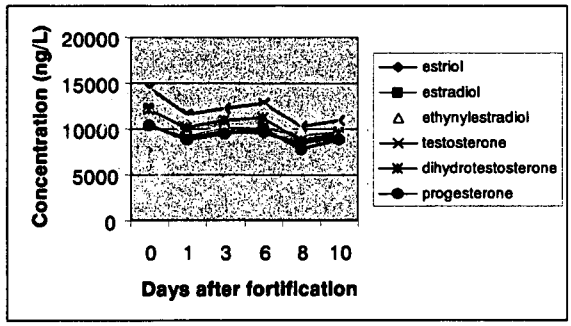
Stability of estriol over time



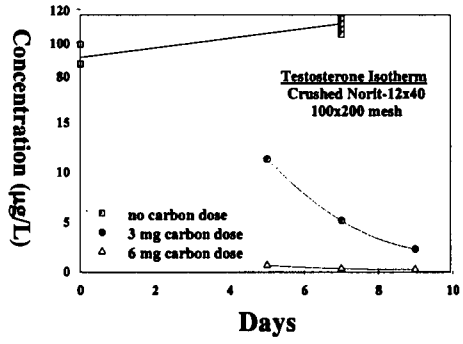
Stability of ethynylestradiol over time



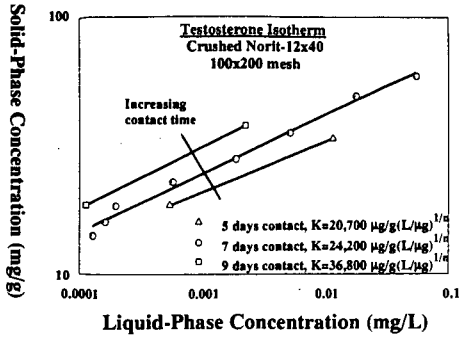
Stability of steroids in filtered buffer



Activated Carbon Treatment



Activated Carbon Treatment



This study will provide information on:

currently available drinking water treatment technologies that can remove EDCs, specifically the steroid hormones and the alkylphenolic compounds.

approaches to optimize these treatment technologies for EDC removal.