Emerging treatment methods for the removal of cyanotoxins from drinking water with focus on Advanced Oxidation Processes

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Cyanobacteria form blooms in freshwaters due to environmental pollution and can produce taste and odour compounds, but also substances that have been shown to be toxic to animals, humans and other organisms. Numerous events of cyanotoxin-associated poisonings of pets, livestock, birds, wildlife and humans, and in some cases even subsequent death, occurred – and still occur – globally. These mainly waterborne secondary metabolites can adversely affect the quality of water intended for drinking and recreational purposes. So far, most countries have not yet enforced strict regulations regarding maximum tolerable cyanotoxin levels in drinking water. Some countries adapted the WHO provisional guideline value of 1 µg/L for microcystin-LR or amended it for country-specific regulatory values. Due to their diversity, fluctuating environmental occurrence and concentration, conventional drinking water treatment can result in insufficient removal of cyanotoxins.

Advanced Oxidation Processes (AOPs) are emerging treatment methods that have been shown to be very promising for the removal of organic pollutants in general, also providing a potential for the removal of cyanotoxins. AOPs promote the *in situ* formation of highly reactive radicals, mainly hydroxyl radicals, and other mechanisms. Hydroxyl radicals are non-selective and randomly attacking oxidants, usually reacting with rate constants orders of magnitude higher than for other oxidants. So far, most research focuses on treatment of microcystins, but other toxin classes such as nodularins, saxitoxins, cylindrospermopsin and anatoxins have also been shown to be susceptible to be removed by AOP treatment. The most often reported AOPs for the removal of cyanotoxins include ozonation, (photo-)Fenton oxidation, direct and catalyst-enhanced photolysis, and combinations of these or with hydrogen peroxide. Lesser studied, but still very promising AOPs for the removal of cyanotoxins from drinking water are sonolytic and hydrodynamic cavitation, electrochemical oxidation, radiolysis and other novel approaches such as those based on non-thermal plasmas. The present paper summarizes pros and cons of AOP technologies for the removal of cyanotoxins from drinking water and presents the first experimental outcomes of studies characterizing the potential and novel AOPs for the removal of less explored cyanobacterial metabolites and their mixtures.

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