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Short Communication

Effect of magnetic iron oxide nanoparticles in surface water treatment: Trace minerals and microbes

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HIGHLIGHTS

- ▶ Protein-functionalized and magnetic iron oxide nanoparticles for surface water treatment.
- ▶ No significant difference in mineral ion concentration.
- ▶ Effective reduction of microbial content and turbidity levels.
- ▶ The application of nanoparticles, could be a complement to the existing treatment process.

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ABSTRACT

The existing water treatment process often uses chemicals, which is of high health and environmental concern. The present study focused on the efficiency of microemulsion prepared magnetic iron oxide nanoparticles (ME-MIONs) and protein-functionalized nanoparticles (MOCP + ME-MIONs) in water treatment. Their influence on mineral ions and microorganisms present in the surface water from lake Brunnsviken and Örlången, Sweden were investigated. Ion analysis of water samples before and after treatment with nanoparticles was performed. Microbial content was analyzed by colony forming units (CFU/ml). The results impart that ME-MIONs could reduce the water turbidity even in low turbid water samples. Reduction of microbial content (98%) was observed at 37 °C and more than 90% reduction was seen at RT and 30 °C when compared to untreated samples from lake Örlången. The investigated surface water treatment method with ME-MIONs was not significantly affecting the mineral ion composition, which implies their potential complement in the existing treatment process.

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1. Introduction

Surface water and ground water are being used as a source for water treatment for human consumption. Potable water should be free from biological contaminants (bacteria, viruses, parasites), trace minerals (boron, calcium, chloride, copper, molybdenum, potassium, zinc, magnesium, manganese etc.); and nutrients (phosphate, ammonia, nitrate) (Othman and Abdullah, 2010). Microbial population in fresh water is mostly dependent upon biomass, pH, nutrient composition, temperature and water flow which often leads to the distribution of bacterial taxa (Lindström et al., 2005). Therefore the water treatment process is critical and varies depending on the water quality that enters the treatment plant.

In surface water, most particles including microbes have a negative charge hence they repel each other rather than forming aggregates. Aluminum or ferric ions are usually employed as coagulant agent in water treatment process. However, the presence of aluminum residues in treated water has health and environmental concerns like neurotoxicity and possibly Alzheimer's disease (Rondeau et al., 2001). Besides, the removal of microorganisms is more focused on microbial ecology distribution systems by adding chlorine or ozone or UV treatment that will enhance safety and high quality drinking water (Berry et al., 2006). Nevertheless, the disinfectant by-products are of health concern and the cost of ozone or UV treatment takes away the benefits of the treatment process.

Currently, advances in nanoscale science and engineering suggest that nanomaterials have great potential to improve water quality in a cost-effective way whilst, with increased reduction in the level of water contaminants (Debrassi et al., 2012). Magnetic iron oxide nanoparticles are good candidates for the development of high-capacity sorbents linked with surface modification to enhance their selectivity/affinity for the reduction or removal of chemical ions and microbes in waters (Theron and Walker, 2008). Conversely, adsorption with magnetic iron oxide nanoparticles is considered as

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