Inactivation of *Ascaris* eggs in water using hydrogen peroxide and a Fenton type nanocatalyst (FeOx/C) synthesized by a novel hybrid production process

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ABSTRACT

Inactivation tests of *Ascaris* eggs (Ae) were performed using hydrogen peroxide and a Fenton type nanocatalyst supported on activated carbon (AC) (FeOx/C). Blank inactivation tests were also carried out using H_2O_2 and H_2O_2/AC as oxidation systems. The FeOx/C nanocatalyst was synthesized through a novel hybrid method developed in this work. The method is based on the incipient impregnation technique, using isopropyl alcohol as dissolvent and chelating agent of the iron salt and the ultrasonic method. The supported nanocatalyst contained 2.61% w/w of total iron and the support 0.2% w/w. Transmission electron microscopy (TEM)–energy dispersive spectrometer (EDS) images permitted verification of the presence of finely dispersed FeOx nanoparticles, with sizes ranging from 19 to 63 nm. SEM–EDS analysis and TEM images also showed good dispersion of iron oxide nanoparticles, most probably maghemite; γ-Fe_2O_3, able to produce hydroperoxyl radical as reported in the literature. The FeOx/C nanocatalyst-H_2O_2 system showed an average Ae inactivation efficiency of 4.46% Ae/mg H_2O_2. This value is significantly higher than the result obtained using the support-H_2O_2 system and H_2O_2 alone and it is also better than data reported for the classical Fenton process (homogeneous phase) with or without UV light.

Key words | helminth, heterogeneous Fenton-like reaction, iron oxides, pathogen, reactive oxygen species

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INTRODUCTION

Wastewater is a valuable resource for agricultural use in regions where water resources are scarce. However, its reuse may pose substantial health risks for the agriculturists and consumers, particularly in developing countries, due to the presence of pathogens in raw wastewater, such as helminth eggs (Scoot 2008). Navarro & Jiménez (2011) have reported a content of 70–3,000 helminth eggs/L (He/L) in municipal wastewater of developing countries, which is significantly higher than the value recommended by the WHO (1989) for agricultural irrigation (<1 He/L). *Ascaris* eggs (Ae) are the manifestation of the most common helminth species (84%) identified in wastewater and sludge (Jiménez 2007). This parasite affects 25–33% of the world population, mainly in developing countries (Africa, Latin America and the Far East) (Jiménez 2007). Ae are recalcitrant to most disinfection processes due to their shell, consisting of four organic layers of 3–4 μm thick which protect the eggs, allowing them to remain viable for a long time even under extreme environmental conditions (Brownell & Nelson 2006).

Nelson & Darby (2001) have investigated the validity of using *A. suum*, which infects pigs instead of *A. lumbricoides*, which infects humans, in inactivation tests. Although small genetic differences exist between them, they concluded that their response to inactivation treatments is sufficiently similar to use the more easily

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