Disinfection Potential of the Catalytic Wet Peroxide Oxidation (CWPO) for Inactivation of Intestinal Parasites *Giardia lamblia* and C*ryptosporidium parvum*

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Introduction

WHO (World Health Organization) has estimated that around 24 % of the diseases at a global scale are related to environmental factors like consumption of insecure drinking water. Recent laws have become more stringent about the permitted parameters of quality, including more careful surveillance on the presence of resistant forms of *Giardia* (cysts) and *Cryptosporidium* (oocysts) in water for human consumption. It has been pointed out that some particular physicochemical properties of their cysts/oocysts cell walls make them strongly resistant against conventional chlorine disinfection [1]. Moreover, complex mechanisms there implied are not still completely elucidated.

Therefore, conventional disinfection by chlorine should be assisted or even replaced by novel, safer technologies like the advanced oxidation processes (AOPs). The CWPO is a very efficient, not expensive AOP [2] that could offer a very interesting performance for effective and safe inactivation of resistant pathogen agents like the cysts/oocysts of the intestinal parasites *Giardia* and *Cryptosporidium*, even under very mild conditions of ambient temperature and pressure (15 – 25 ℃; < 1 atm). This work is devoted to explore the true potential of the CWPO technology in the inactivation of these couple of resistant forms of dangerous parasites.

Materials and Methods

The CWPO reaction was activated by an Al/Fe-PILC catalyst prepared as already reported [2]. In a glass 500 mL semi-batch reactor provided with continuous magnetic stirring and air bubbling were placed 400 mL of ultrapure water doped with 20 cysts of *G. lamblia* and 20 oocysts of *C. parvum* and the desired amount of catalyst. The factors studied were: peroxide concentration (7.4 mg/L, 74.2 mg/L, 148.4 mg/L y 222.6 mg/L) and catalyst loading (0.5 g/L, 2.75 g/L and 5 g/L). For comparison two blanks were also prepared with the same doped system but without using either, hydrogen peroxide addition or catalyst addition. Viability of the cystic forms was determined once finished every catalytic experiment (time of reaction = 1 h). 400 mL of the effluent were concentrated, purified and measured by microscopy of epifluorescense, previous staining with DAPI, IP and IFTC [3-5]. The significance of the percentages of recovery and elimination of cysts/oocysts was estimated by multifactorial ANOVA.

Results and Discussion

The method used to follow the viability of the cysts/oocysts of *G. lamblia* and *C. parvum*, respectively was satisfactory. Recoveries of cysts and oocysts reached 60 % for cysts and 80 % for oocysts.

Percentages of elimination over 95 % were achieved for cysts of *G. lamblia*, whereas exceeded 90 % for oocysts of *C. parvum.* It is a very promising result about the potential of the CWPO technology to be involved in disinfection processes of surface waters to produce safe drinking water. In contrast, studies have evidenced that chlorine disinfection requires dosages and times of contact exceeding the permitted values for microorganism inactivation, besides increasing the chemical risk of formation of hazardous disinfection by-products DBPs [6]. The observed activity could be attributed to strong attack of the hydroxyl radicals on most organic functionalities constituting the cysts/oocysts membranes, including proteins and lipids; subsequent damages on the inner parts of the cysts and oocysts may also take place [7]. The results also showed a higher resistance of the oocysts of *C. parvum* in comparison to the cysts of *G. lamblia*, against the CWPO treatment. Such a higher resistance of the *C. parvum* oocysts has also been reported with other disinfecting agents and it can be ascribed to more complex composition and structure of the cystic membrane of this parasite [1,4].

The multifactorial ANOVA indicated that peroxide dosage does not exert a statistically significant effect on the elimination of *C. parvum* oocysts within the range of concentrations studied, but it does on the elimination of *G. lamblia* cysts. For this last one, it was clearly observed that lower tested peroxide concentration (7.4 mg/L) was less efficient than the other ones (74.2 mg/L; 148.4 mg/L y 222.6 mg/L). On the other hand, the multifactorial ANOVA for catalyst loading showed that this factor does not exert statistically significant effect on the elimination of neither two cystic forms of the targeted parasites. It probably suggests that even the lower catalyst loading here studied (0.5 g/L) provided enough catalytic centers to activate the complete range of peroxide concentrations.

Significance

As long as we know, this is the first report about the disinfecting potential of the CWPO advanced oxidation process in the elimination of cystic forms of microorganisms highly resistant to the conventional methods of chemical disinfection, displaying fairly promising percentages of elimination under pretty mild conditions of temperature and pressure.

References

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