



3rd
INTERNATIONAL WORKSHOP
ADVANCES IN CLEANER PRODUCTION

“CLEANER PRODUCTION INITIATIVES AND CHALLENGES FOR A SUSTAINABLE WORLD”

Coagulation/Flocculation Process with Seeds of *Moringa oleifera* Lam for the Removal of *Giardia* Cysts and *Cryptosporidium* Oocysts from Water

L. Nishi ^{a*}, G. S. Madrona ^a, A. M. S. Vieira ^a, F. J. Bassetti ^b, G. F. Silva ^c, R. Bergamasco ^a

a. Universidade Estadual de Maringá, Maringá, leticianishi@hotmail.com.

b. Universidade Tecnológica Federal do Paraná, Curitiba, bassetti@utfpr.edu.br

c. Universidade Federal de Sergipe, São Cristóvão, gabriel@ufs.br

*Bolsista Conselho Nacional de Desenvolvimento Científico e Tecnológico

Abstract

Waterborne diseases occur worldwide, and outbreaks caused by the contamination of community water systems have the potential to cause disease in large numbers of consumers. Among waterborne diseases, gastroenteric ones are the most frequent. Approximately, 19% of outbreaks in the USA are attributed to parasitic protozoans, especially species of *Giardia* and *Cryptosporidium* because of their wide distribution in the environment, high incidence and resistance to conventional chlorination treatment. In conventional water treatment, several chemical coagulants are used, most commonly aluminum sulfate, although the production of non-biodegradable sludge and indications of damage to health have led to a search for other coagulants that are less harmful to the environment and to human health. Therefore, several natural coagulants are being studied, such as the seeds of *Moringa oleifera*. The objective of this study was to assess the efficiency of moringa seeds as a coagulant for the removal of *Giardia* and *Cryptosporidium* (oo)cysts, color and turbidity from raw water. To carry out the coagulation assays, raw water was artificially contaminated with these protozoans. This water was submitted to coagulation/flocculation with different dilutions of a stock solution of 1 % moringa seeds, and the mixtures were tested in a jar test apparatus. The water samples were analyzed before and after the coagulation assays. In order to assess (oo)cysts removal, samples were analyzed by the membrane-filtration technique, with mechanical extraction and elution followed by direct immunofluorescence technique. Water color and turbidity were measured according to the procedure recommended by the Standard Methods. Concentrations above 150 mg/L from the 1% solution of moringa seeds gave the best (oo)cysts removal, about 94% to *Giardia* cysts and 90% to *Cryptosporidium* oocysts. Turbidity removal ranged from 0 to 97.4%, color removal varied from 6.7% to 73.5%. Color and turbidity removal were found to be dependent on the initial turbidity of the water sample and the concentration of coagulant. Coagulation with moringa seeds gave satisfactory results in reducing the number of protozoan parasites (oo)cysts. The use of *M. oleifera* Lam seeds can be considered advantageous and a promising step towards improving the processes of water coagulation/flocculation to remove these protozoans.

Keywords: *Giardia*, *Cryptosporidium*, *Moringa oleifera*, coagulation/flocculation.

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São Paulo – Brazil – May 18th-20th - 2011