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Biochars made from agro-industrial by-products remove chlorine and lower water toxicity

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Chlorination is the most common disinfection process for water and treated wastewater. For the industrial use of water in food production, chlorine can add undesired taste and odor to the final product. For this reason, dechlorination is desired for food industries that use municipal tap water. For treated wastewater discharge or reuse, chlorine can be toxic to the receiving aqueous systems and to the irrigated plants. In both the above cases, dechlorination is also required. Traditionally activated carbon has been used as the ideal material for the removal of chlorine. The main mechanisms that describe the interaction between activated carbon and HOCl or OCl- are described by the following equations (AWWA, 1990):

HOCl + C* → C*O + H+ + Cl- (1), OCl- + C* → C*O + Cl- (2)

Where C* and C*O represent the activated carbon surface and a surface oxide, respectively. The present study proposes the use of agro-industrial by-products for the production of biochars that will be used for dechlorination of tap-water used for food-industry production. Different raw materials such as malt spent rootlets, coffee residue, olive and grape seeds, etc. are used for the production of biochar. Various temperatures and air-to-solid ratios are tested for optimizing biochar production. Batch tests as well as a column test are employed to study the dechlorination efficiency and kinetics of the different raw and biochar materials as well as those of commercial activated carbons. As chlorine concentration increases the removal also increases linearily. After 1 and 24 hours of contact the chlorine relative removal efficiencies for the biochar made from olive seeds are 50 and 77 ± 4%, respectively. It seems that the removal kinetics are faster during the first hour; then, removal continues but with a slower rate. Most of the biochars tested (with 3 mg of solid in 20 mL of chlorine solution at initial concentration Co=1.5 mg/L) demonstrated removal efficiencies with an average of 9.4 ± 0.5 mg/g. For the two commercial activated carbons, removal efficiencies were 11.4 ± 0.2 mg/g. The column experiment also showed positive results; no breakthrough has been observed after 1L of chlorine solution has passed through a column packed with 4 g of biochar made from the pyrolysis of grape seeds. Toxicity tests were also performed with the chlorine solution before and after passing through this column. The toxicity of the solution decreased after passing through the column packed with biochar suggesting that no toxic compounds are formed during the removal of chlorine by the biochar. The overall idea of this study is the sustainable use of the solid by-products of a food industry or producer to treat water or treated wastewater in order to enhance its quality and lower its toxicity.

American Water Works Association (AWWA) 1990 Water quality and treatment, a handbook of community water supplies, Fourth edition.