Disinfectious Effect of Ozonation on Water Infested with Several Root-Infecting Pathogens

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As the use of hydroponic culture to grow vegetables (*e.g.* tomatoes, lettuce) has increased, so too have problems with root-infecting pathogens responsible for some business failures. Although, proper disinfection procedures should prevent this, several root-infecting pathogens have been reported on vegetables in recirculating hydroponic systems^{1,2)}.

Ozone, as a disinfectant to purify drinking water, came into use in 1906 in France, and since has been adopted by more than 1,000 facilities throughout Europe³⁾. In North America, interest in ozone is increasing as a result of a need to reduce levels of chlorine in water treatment, in keeping with legislated maximum contaminant levels for trihalomethanes⁴⁾.

In this paper, the authors examined the effect of ozonation on several common root-infecting pathogens to determine whether ozonation is suitable for disinfection of source water for hydroponic solutions.

Test organisms. Plant pathogens tested in this experiment were as follows:

Corynebacterium michiganense pv. *michiganense* (E.F. Smith) Jensen (Strain 4)

Pseudomonas solanacearum E.F. Smith (Strain P1-18-1)

Erwinia carotovora subsp. *carotovora* (Townsend) Holland (Strain E7105)

Fusarium oxysporum Schlechtendahl f. sp. *lycopersici* (Saccardo) Snyder (Strain SU-72)

Ozonation and viable cell count. The test organisms were incubated with shaking at 25 C in PS medium (decoction of 200 g of potato, 30 g of sucrose, 1 liter of distilled water) for 3 days. The bacterial cells were harvested by centrifugation (2,000 × g, 10 min) and washed twice with sterile distilled water. The microconidia-like budding cells of *F. oxysporum* were filtered with sterile gauze to remove filamentous mycelia, and harvested as above. The respective harvested cells were suspended at a density of 5×10^3 – 5×10^4 cells/ml solution (determined with a hemocytometer) in 10 liter of autoclaved salts solution in stainless steel tank (45 cm h. × 25 cm dia.) with a narrow top opening (5 cm dia.). The solution contained 0.2 g of $\text{MgSO}_4 \cdot 7\text{H}_2\text{O}$, 0.5 g of $\text{NH}_4\text{H}_2\text{PO}_4$, 0.9 g of KNO_3 , 0.8 g $\text{Ca}(\text{NO}_3)_2$, 0.1 mg of $\text{CuSO}_4 \cdot 5\text{H}_2\text{O}$, 0.2 mg of $\text{ZnSO}_4 \cdot 7\text{H}_2\text{O}$, 0.02 mg of Na_2MoO_4 , 2 mg of $\text{MnCl}_2 \cdot 4\text{H}_2\text{O}$, 3 mg of H_3BO_3 , 20 mg of Fe-EDTA in 1 liter of distilled water. The suspension was ozonated at a rate of 10 liter/min using a ozone generator (Fujimori Sangyo Co., Ltd. OZW-MN200, cold plasma discharge method). The control suspension was aerated at the same flow rate. A portion of the suspension was sampled after 0, 15, 30, 60, 90 and 120 min ozonation or aeration, and diluted adequately with sterile distilled water. The diluted suspension was plated onto PS agar medium and incubated at 28 C. After 3 days, colonies appearing on the agar plates were counted, and the number of viable cells in the suspension at the time of sampling was estimated from the count.

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Fig. 1. Changes in viable cell number of *Corynebacterium michiganense* (A), *Erwinia carotovora* (B), *Pseudomonas solanacearum* (C) and *Fusarium oxysporum* (D) in the solution accompanying ozonation (open circle) and aeration (solid circle).

Figure 1 shows changes in viable cell number accompanying ozonation and aeration of *C. michiganense*, *E. carotovora*, *P. solanacearum* and *F. oxysporum*. In no case did aeration change the viable cell number in the suspension during the test periods, while ozonation decreased the viable cell number immediately. Sixty min ozonation for *C. michiganense* and *P. solanacearum*, 90 min for *E. carotovora* and 120 min for *F. oxysporum* reduced the respective number of viable cells in the suspension to 1 cell/ml or less. The sensitivity to ozonation of *F. oxysporum*, the only fungus among the tested organisms, was less than that of the bacteria, but after ozonation for 120 min, the survival of the fungus was nearly zero. In this experiment, however, microconidia-like budding cells were used as a fungal inoculum. Chlamydospores could possibly require longer ozonation treatment to be completely sterilized.

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和 文 摘 要

山本広基・寺田俊郎・長縄貴彦・達山和紀：土壌伝染性植物病原菌を混入した試水のオゾンによる消毒

水耕液として使用する水の消毒手段としてのオゾン処理の適否を検討する目的で、水 (10 l) に $5 \times 10^3 \sim 5 \times 10^4$ /ml となるように混入した *Corynebacterium michiganense*, *Erwinia carotovora*, *Pseudomonas solanacearum* あるいは *Fusarium oxysporum* f. sp. *lycopersici* の生存に及ぼすオゾン処理の影響を試験した。水中の *C. michiganense* および *P. solanacearum* は 60 分間の、*E. carotovora* は 90 分間の、そして *F. oxysporum* は 120 分間のオゾン曝気 (10 l/min) によってほとんど検出されなくなる程度まで減少した。

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