

**Title** Shelf-life of minimally processed lettuce and cabbage treated with gaseous chlorine dioxide and cysteine

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### Abstract

Gaseous ClO<sub>2</sub> was evaluated for effectiveness in prolonging the shelf-life of minimally processed (MP) lettuce and MP cabbage, previously immersed in a cysteine solution in order to inhibit browning occurring during ClO<sub>2</sub> treatment. Each vegetable was shredded, washed, and separated in two portions, one to be treated with ClO<sub>2</sub> gas and the other to remain untreated as reference sample. The batch to be treated with ClO<sub>2</sub> gas was immersed for 1 min in a 0.5% solution of HCl · l-cysteine monohydrate. Then both batches were spun dried. MP vegetables were decontaminated in a cabinet at 90–91% relative humidity and 22–25 °C up to 10 min, including 30 s of ClO<sub>2</sub> injection into the cabinet. The ClO<sub>2</sub> concentration rose to 1.74 mg/L (MP lettuce) and 1.29 mg/L (MP cabbage). Then samples were stored under modified atmosphere at 7 °C for shelf-life studies. Changes in O<sub>2</sub> and CO<sub>2</sub> headspace concentrations, microbiological quality (aerobic plate count (APC), psychrotrophs, lactic acid bacteria, and yeasts), sensory quality, and pH were followed during storage. The respiration rate of the minimally processed vegetables was significantly increased by the ClO<sub>2</sub> gas treatment only in the case of MP cabbage ( $P < 0.05$ ). The gas treatment reduced initially APC and psychrotroph count of MP lettuce and APC, psychrotroph counts, yeast counts and pH of MP cabbage ( $P < 0.05$ ). ClO<sub>2</sub> treatment did not cause initially any significant ( $P < 0.05$ ) sensorial alteration, except for a weak off-odour in MP lettuce. Interestingly, no browning was observed after treating, which can be accounted to the use of l-cysteine. Although an initial microbiological reduction was observed due to ClO<sub>2</sub> gas treatment, APC and psychrotroph counts reached in the samples treated with ClO<sub>2</sub> higher levels than in those non-treated with ClO<sub>2</sub> before the third day of the shelf-life study. Untreated and treated samples of MP lettuce were sensorial unacceptable due to bad overall visual quality after 4 days, while treated and untreated MP cabbage remained sensorial acceptable during the 9 days of the study. l-cysteine reduced ( $P < 0.05$ ) the decontamination efficacy of ClO<sub>2</sub> when applied to MP cabbage but not in the case of MP lettuce. Gaseous ClO<sub>2</sub> failed to prolong the shelf-life of MP lettuce and MP cabbage, the reason for the enhanced growth of microorganisms in decontaminated samples should be investigated. Nonetheless, our results prove that it is possible to inhibit browning caused by ClO<sub>2</sub>.