

Title Shelf-life extension of minimally processed carrots by gaseous chlorine dioxide
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Abstract

Chlorine dioxide (ClO₂) gas is a strong oxidizing and sanitizing agent that has a broad and high biocidal effectiveness and big penetration ability; its efficacy to prolong the shelf-life of a minimally processed (MP) vegetable, grated carrots (*Daucus carota* L.), was tested in this study. Carrots were sorted, their ends removed, hand peeled, cut, washed, spin dried and separated in 2 portions, one to be treated with ClO₂ gas and the other to remain untreated for comparisons. MP carrots were decontaminated in a cabinet at 91% relative humidity and 28 °C for up to 6 min, including 30 s of ClO₂ injection to the cabinet, then stored under equilibrium modified atmosphere (4.5% O₂, 8.9% CO₂, 86.6% N₂) at 7 °C for shelf-life studies. ClO₂ concentration in the cabinet rose to 1.33 mg/l after 30 s of treatment, and then fell to nil before 6 min. The shelf-life study included: O₂ and CO₂ headspace concentrations, microbiological quality (mesophilic aerobic bacteria, psychrotrophs, lactic acid bacteria, and yeasts), sensory quality (odour, flavour, texture, overall visual quality, and white blushing), and pH. ClO₂ did not affect respiration rate of MP carrots significantly ($\alpha \leq 0.05$), and lowered the pH significantly ($\alpha \leq 0.05$). The applied packaging configuration kept O₂ headspace concentrations in treated samples in equilibrium and prevented CO₂ accumulation. After ClO₂ treatment, the decontamination levels (log CFU/g) achieved were 1.88, 1.71, 2.60, and 0.66 for mesophilic aerobic bacteria, psychrotrophs, and yeasts respectively. The initial sensory quality of MP carrots was not impaired significantly ($\alpha \leq 0.05$). A lag phase of at least 2 days was observed for mesophilic aerobic bacteria, psychrotrophs, and lactic acid bacteria in treated samples, while mesophilic aerobic bacteria and psychrotrophs increased parallelly. Odour was the only important attribute in sensory deterioration, but it reached an unacceptable score when samples were already rejected from the microbiological point of view. The shelf-life extension was limited to one day due to the restricted effect of the ClO₂ treatment on yeast counts. Nevertheless, ClO₂ seems to be a promising alternative to prolong the shelf-life of grated carrots.