Studying the kinetics of ozone decomposition during postharvest treatments in fresh-market peaches

Georgia Peach Council

Fort Valley, GA

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Abstract

Ozone is a very potent oxidizing agent which is effective in killing a wide spectrum of microorganisms by oxidation of their cell membranes. It is reported to have 1.5 times the oxidizing potential of chlorine which makes it a good alternative surface sanitizer for fresh fruits and vegetables. Furthermore, ozone is a very unstable gas which decomposes in a very short time to molecular oxygen leaving no chemical residues or undesirable byproducts. This instability, however, necessitates on-site generation and timely application as ozone cannot be stored or transported. Since ozone is a gas, it has low solubility in water and it has been found to dissipate rather quickly when mixed in aqueous solutions. A novel technology called High-Oxygen Water (HOW) has risen as an alternative sanitation system which is based on the generation of stable nanobubbles of oxygen in water that can be coupled with ozone. Since nanobubbles are very small in size, they rise slowly to the water surface and allow for the gas inside them to be completely dissolved in the water. There exists a gaseous treatment of ozone which can be applied overtime in cold rooms containing fresh produce. Gaseous and aqueous ozone decompose at different rates depending on various external factors such as the temperature of application, relative humidity, pH as well as organic matter present. In this study we investigated the effect of organic matter presence in the form of freshly harvested peaches on ozone decomposition rates. Our team mapped the kinetics of different forms of ozone application and studied the reduction in oxidative potential with the addition of unsanitized peaches which were harvested from a commercial orchard. This work clarifies the constraints of using ozone as a sanitizer based on the oxidative potential reduction over time.

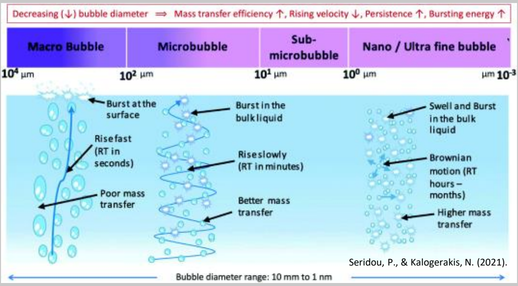
Materials & Methods

- Fresh peaches (cvs. Britney Lane, Fiesta Gem)
- NABAS (Nano Air Bubble Aeration System) generator
- YSI ProQuatro handheld multiparameter meter
- MECMESIN firmness analyzer
- KONICA MINOLTA Chroma meter CR-400
- BRIDGE map gas analyzer CO_2/O_2

Fruit were immersed for 30 minutes in 20 Gal. buckets using 5 different concentrations:

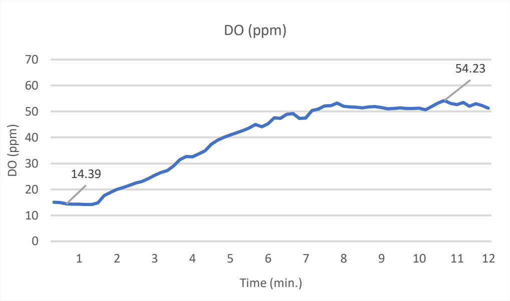
- Chlorinated water 50 ppm
- Water with 10 ppm Dissolved Oxygen (DO)
- Water with 20 ppm Dissolved Oxygen (DO)
- Water with 30 ppm Dissolved Oxygen (DO)
- Water saturated w/ Ozone (O_3)

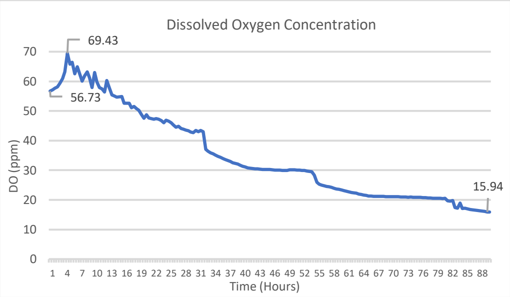
Ozone (O_3)	
Pros	**Cons**
1.5 times stronger oxidizing agent than chlorine	Could damage rubber and other polymers
Hydroxyl Radicals production	Short shelf-life in water (< 30 minutes), cannot be stored.
Autodecomposition, leaves no toxic residues	Oxidizes all organic material present incl. produce
Ozonated water can be recycled to reduce water usage	Potential health risks for workers
Compatible with organic food processing	High upfront setup costs

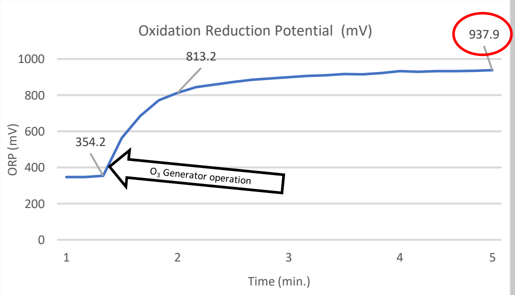


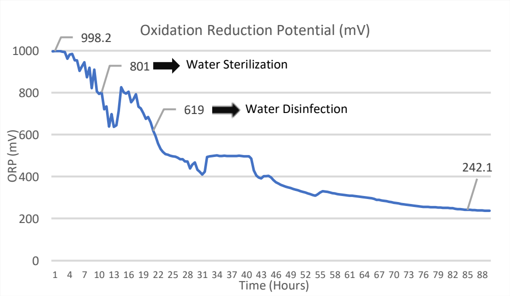
Seridou, P., & Kalogerakis, N. (2021).

Effects of high O_3 levels on fresh peach quality









Conclusions

- Dissolved oxygen (DO) levels plateaued after 8 minutes of unit operation at approx. 52-55 ppm
- DO concentration declined over time reaching to 16 ppm after 85 hours (3.5 Days)
- Oxidation Reduction Potential (ORP) increased immediately upon the initiation of ozone generation, reaching at a maximum of approx. 940 mV after 5 minutes of ozone generator operation
- ORP declined over time; remaining at high levels (at or above the disinfection capacity for at least 24 hours)

Citations

1. Palou, Lluís, Joseph L Smilanick, and Dennis A Margosan. 2007. "Ozone Applications for Sanitation and Control of Postharvest Diseases of Fresh Fruits and Vegetables." *Recent Advances in Alternative Postharvest Technologies to Control Fungal Diseases in Fruits and Vegetables*, 39–70.

2. Rose, Seth, and Austin Long. 1988. "Monitoring Dissolved Oxygen in Ground Water: Some Basic Considerations." *Groundwater Monitoring & Remediation* 8 (1): 93–97. https://doi.org/10.1111/j.1745-6592.1988.tb00981.x.

3. Seridou, Petroula, and Nicolas Kalogerakis. 2021. "Disinfection Applications of Ozone Micro-and Nanobubbles." *Environmental Science: Nano*.

4. Smilanick, Joseph L, Carlos Crisosto, and Franka Mlikota. 1999. "Postharvest Use of Ozone on Fresh Fruit." *Perishables Handling Quarterly* 99: 10–14.