POSTHARVEST CENTER
UNIVERSITY OF CALIFORNIA

FEBRUARY 2018

What's Key in this Issue

Director's Note

Once more…Into the Ozone

We are riding another wave of keen interest in the potential for ozone-treated water to supplement or wholly substitute for current antimicrobials added to postharvest wash and cooling water. Similarly, gaseous ozone and ozone-fogging applications are triggering cautious interest for surface sanitization in pre-coolers and cold storage.

The attraction to drop other chemistries, predominantly various chlorine-based formulations, in favor of ozone is clear:

- Ozone is a powerful oxidizing agent
- Ozone is FDA listed as Generally Recognized As Safe (GRAS)
- Ozone is allowed as an "ingredient" under the USDA National Organic Program
- Ozone lethality to viruses and parasites in contaminated water far exceeds chlorination
- Ozone treatment enhances water reuse systems by micro-flocculation of suspended particulates
- Ozone has been shown to degrade pesticide residues in reuse water, recirculated produce wash water systems, and on produce surfaces (in controlled lab studies)
- Ozone creates negligible disinfection by-products (identified concern is if water is brominated as well)
- Ozone breaks down to atmospheric oxygen

Postharvest water ozonation, in particular, in both raw fresh and minimally-processed produce sector has increased over the past ten years. Ozone generation and delivery device suppliers (ozone generators) cite recognized safe and effective use in water treatment since the early 1800's, with levels as low as 1 ppm (treatment efficacy at this dose limited to highly filtered systems). As an antimicrobial oxidizer, Ozone > Peroxyacetic Acid > Hydrogen Peroxide > Hypochlorous Acid > Chlorine Dioxide. However, decades of promise from bench-top studies and volumes of peer-reviewed papers have not resulted in broad and effective application of water ozonation in fresh produce packing as the sole antimicrobial additive to a postharvest packing process. Along with the impressive list of beneficial traits, there are equally apparent limitations to both effective and safe applications.

Upfront, I want to share that I have conducted many lab, pilot-scale, and on-site tests with various ozone-based systems for over 25 years, most recently within the past six months. In my experience, the most straightforward and beneficial use of ozone in postharvest handling and packing is as a terminal rinse step and as the post-ultrafiltration treatment of re-circulated water in postharvest wash and fluming systems.

Another commonly cited beneficial application is in cold storage or forced-air treatment with gaseous ozone or room fogging. The most cost effective applications to room ozonation, in my experience, are for bulk-stored product packed to order rather than pre-packed and palletized cartons. In long-term cold storage, whole system design including bin stacking, sensor deployment, and detailed airflow mapping to minimize dose gradients are critical for beneficial outcome within a lot and to prevent ozone injury to the product, especially

during storage and distribution. Additionally, the cost of facility and equipment conversion or design to ozone-compatible materials and components must be considered.

A tree fruit grower/shipper recently asked me, "Why can't we make ozone work in our pack-line?" My simple answer was that you likely could if you develop an **integrated system** to allow it to provide a benefit. Don't expect a 'silver bullet' outcome to microbial control objectives with ozone; don't rely on a simple plug-and-play marketing scheme to work by merely installing an ozone generator and injection point. You have to define your expectations for where and how your operation will realize a value to product quality and environmental management.

A key issue here is that the majority of peer-reviewed journal papers extolling the promise of both gaseous, fogging, and aqueous ozone treatment for quality, decay control, and food safety fail to provide a true practical context for efficacy expectations to the end-user. Without getting too deep into the weeds of technical issues and experimental methods, the microbial challenges using lab-grown cells are too likely to over-predict lethality in a commercial context. In the absence of a demonstrated performance in lethality to naturally occurring and environmentally adapted index microbes, expectation for claimed 99.99 or 99.999% kill of some target-inoculated pathogen is highly suspect. Similarly, model systems, which report outstanding pathogen kill potential, often have incompatible parameters for dose and product exposure duration or uniformity of contact which is highly unlikely to be matched in high-throughput handling systems.

One of the common pitfalls is matching the ozone Ct exposure (Concentration x Time) curves for phytotoxicity (product injury) to microbial disinfection (log kill) of the naturally present index microbes mentioned above. Some commodities have good ozone exposure tolerance but our experience has been that a number of inherent product traits or mixed tissue type (such as tolerant fruit but highly sensitive green calyx or tender "caps-stem") and the preharvest factors influencing susceptibility to injury fall well below the threshold for beneficial levels of pathogen control, whether postharvest decay spores or foodborne human pathogens.

Most recently, I have had the opportunity to observe systems in a few locations with recent installations of ozonated wash-rinse systems for fruit handling, as either a low-pressure spray or waterfall application to maximize retention of dissolved ozone and minimize worker discomfort or injury from excessive off gassing. From some preliminary tests, the greatest benefit is realized for in-shift control of microbial build-up on produce contact and immediately adjacent non-contact surfaces. Some minor reduction of microbial levels, above the action of mechanical removal of soil and adhering particulates alone, is likely but highly dependent on product surface traits and lot-specific characteristics.

Despite my tempering the enthusiasm I encounter among ozone disciples, I remain optimistic that as operations evaluate their postharvest quality and food safety goals and apply a full systems approach, integrating ozone will result in practical benefits for some commodities. By doing this and assessing applications in a scientifically valid but practical approach, I feel the best chance to extract the antimicrobial and oxidative benefits of ozone applications may be achieved.

Twitter Challenge

Here's my take on the challenge Tweet we posted.
(If you missed our Twitter challenge, join us on Twitter here.)

You have to have several pieces of information to answer the grower's question. Broccoli was incorrectly included on a blogger's list of produce rarely consumed raw and therefore exempt from requirements applying to covered crops. This old list was incorrect. This was part of the debate requested to be settled. Drip irrigation from the surface water source used for the broccoli production would not meet the FSMA definition of agricultural water as it is not intended or typically expected to contact the harvestable portion of this 'covered' crop. In this particular case (the recent photo used is only to illustrate an identical situation but not the specific grower), other covered crops are also grown using overhead irrigation but from different water sources. These surface water sources are currently being tested on a limited seasonal basis. Preharvest foliar crop management sprays are also a consideration as to whether Microbial Water Quality Profile requirements would apply. With broccoli, contact with the harvestable portion is intended and may in some cases be fairly close to harvest scheduling. In this grower's case, all foliar sprays are prepared using municipal water so no additional testing is required, though recommended at least periodically. A nearby domestic farm residence well is a secondary source which is tested using State Water Board Division of Drinking Water guidance.

Registrations Open for 2018 Workshops!

Fruit Ripening & Ethylene Management Workshop

Need to get current on optimal fruit quality management?

Delivering optimum quality to the end user is especially important when dealing with ripened product. Ripening protocols need to be reliable, predictable and provide the maximum amount of marketable product. Ethylene can be your friend or foe in achieving this…**Can you deliver?**

Join the Postharvest faculty and invited expert speakers from academia and industry on the UC Davis campus for the 24th Annual Fruit Ripening and Ethylene Management Workshop (April 10-11, 2018). See Registration link immediately below.

Learn how to increase profits by reducing losses in short-term storage, in transit, at receiving, and during retail display or foodservice short-term storage. This workshop is open to all, but intended as entry-level awareness and education or a refresher for shippers and fruit handlers (wholesale and retail) who are involved in postharvest handling and ripening of fruits and fruit-vegetables. Procurement managers and officers, vendor category managers, and purchasing agents would also benefit from the workshop content.

For more information on technical content, please contact: Mary Lu Arpaia Ph.D. CE Subtropical Horticulturist.

For more registration information, please contact: Penny Ann Stockdale UC Postharvest Center Program Representative.

Enroll now.

40th Annual Postharvest Technology of Horticultural Crops Short Course

Enrollments have just opened for the June 18-29, 2018 Postharvest Technology of Horticultural Crops Short Course. This course is a one- or two-week intensive study of the biology and current technologies used for handling fruits, vegetables and ornamentals in California.

The first week will be held at the UC Davis Activities and Recreation Center (ARC), and will include lectures and demonstrations on a broad spectrum of postharvest topics.

The second (optional) week is a field tour visiting a variety of postharvest operations throughout central California. The enrollment fee is $2350 for the 1-week session, and $3350 (plus additional required lodging fees) for the 2-week session.

Enroll now.

Featured Postharvest Bookstore Item

Sale! Receive 25% off Fruit Ripening & Ethylene Management

This publication is the course material, developed and updated for the Fruit Ripening & Ethylene Management Workshop which was held April 18 & 19 2017. It includes optimum procedures for ripening a variety of produce, and provides 7 color ripeness charts and numerous color tables and photographs. The publication provides detailed instructions for measuring soluble solids in melons and other fruits, and a helpful resources directory.

Click here to go to the Fruit Ripening page in our bookstore. Use sale code 25Fruit to apply your 25% discount. For a complete listing of all our publications see our bookstore.

Postharvest Gratitude

Thank you to these recent Postharvest Center endowment contributors:

- Mary Lu Arpaia/Christopher Corbett – Century Club
- Matthew Doppke – Century Club
- James and Judith Klaustermeyer – Patron Club
- Anne Plotto – Century Club
- L. George Wilson – Patron Club

These donations help the Center achieve our goals of effectively communicating information to a diverse group of local, national and international growers and industry partners; reducing postharvest losses; and improving the quality, safety and marketability of fresh fruits, vegetables and ornamentals.

It's never too late to contribute. Please visit our Endowment page to make a gift.

Postharvest Positions

FloraLife® Experts in Flower Care

West Coast Technical Sales Representative

The Technical Sales Representative is responsible for executing the sales and marketing plan to accomplish the company's goals and objectives for the assigned territory. The position reports directly to the Floralife Sales Manager.

Essential Duties and Responsibilities

- Call on Supermarket and Mass-Market Corporate Buying Offices, Growers, Grower Distributors, Bouquet Operators and any other customers as assigned by the Sales Manager.
- Promote the sale and proper use of Floralife and OASIS® products to customers
- Represent the company at trade shows at the direction of the Sales Manager.
- Conduct training and in-booth product demonstrations at industry shows and retailer shows
- Make joint calls with other Territory Managers to promote the sales of Floralife and OASIS® products.
- Prepare business plans by account.
- Conduct customer audits as required.
- Provide technical support and troubleshooting for all accounts.
- Identify and pursue new business opportunities.
- Anything else deemed necessary by management.

Qualifications/Requirements

- Three years sales/territory management experience
- Horticulture/Agriculture degree or related field
- Experience with sales to retail and/or wholesale distributors

Contact Clementina Strong at cstrong@smithersoasis.com or 330-945-5116.

On Our Website

Stay up-to-date with the Postharvest Technology Center by joining our Linkedin Group.

New Publications on our Website

Kent J. Bradford, Peetambar Dahal, Johan Van Asbrouck, Keshavulu Kunusoth, Pedro Bello, James Thompson, Felicia Wue 2018. The dry chain: Reducing postharvest losses and improving food safety in humid climates, Trends in Food Science & Technology 71 (2018) 84-93

Pedro Novillo, Alejandra Salvador, Carlos Crisosto, Cristina Besada. 2016. Influence of persimmon astringency type on physio-chemical changes from the green stage to commercial harvest, Sciencia Horticulturae 206 (2016) 7-14.

Irwin R. Donis-Gonzalez, Sanghyup Jeong, Daniel E. Guyer and Dennis W. Fullbright. 2016. Microbial contamination in peeled chestnuts and the efficacy of postprocessing treatments for microbial spoilage management. Journal of Food Processing and Preservation ISSN 1745-4549.

Postharvest Calendar

- April 10 & 11, 2018. **Fruit Ripening & Ethylene Management Workshop**. Davis, CA
- May 30 & 31, 2018. **Continuing Education for Produce Safety Educators Workshop**. Davis, CA
- June 18-29, 2018. **Postharvest Technology of Horticultural Crops Short Course**. Davis, CA, and Central CA
- September 18-20, 2018. **Fresh-cut Products Workshop**. Davis, CA

Ask the Produce Docs

Q. I have been talking with some people in Thailand regarding the Coolbot temperature controller. I am an expat New Zealander, resident in Laos for the last 10 years. I understand you have a project in Cambodia, and would like to know if you think it could work in Laos. (C.P.)

A. I'll I suggest you contact Borarin Buntong at the RUA in Phnom Penh (bborarin@rua.edu.kh). He built the CoolBot room at the University, and also has been involved with ones built by a growers' cooperative and by a Phnom Penh retailer.

Some desk-wallah in the Ministry of Energy in India had the same concern as you about operating a domestic air conditioner outside its design limits, and effectively stifled early efforts to get this technology going in India. Actually the air conditioner is not being operated much outside its design limits - the compressor is turned off when frost forms on the coils, a common occurrence in domestic use. And the actual duty cycle for the air conditioner is only about 50% (half the time, the compressor is off while the fan runs and melts the accumulated frost). Particularly if the unit is being used to store sub-tropical and tropical fruits and vegetables, there is little likelihood of any negative effects of the CoolBot on the AC unit.

Having said that, I'm sure that a manufacturer would argue that the unit had been modified and that the warranty was invalid, should one break down. Practical experience here in the U.S., where north of 14,000 units have been installed, indicates that AC units (window and split) operate fine for many years under CoolBot control. And the great thing about using a domestic AC is that if they break down, parts and repair-men are available even in remote locations.

The most important issues in building a successful CoolBot room (or any coolroom!) are adequate insulation, and, for insulation that is permeable to water vapor, a good vapor barrier on the *outside* of the coolroom.

. Michael Reid

Postharvest Questions. If you have a postharvest question you'd like answered, please send it to postharvest@ucdavis.edu, and we'll see if one of our specialists can help.

Archived Items. Link to a data store of all our previous "Ask the Produce Docs" questions, or link to archived copies of our monthly e-newsletter as PDF documents.

Frequency of Distribution. This publication is produced quarterly, or as special issues by the UC Postharvest Technology Center.
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