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Making Sense of Rules Governing Chlorine Contact in Postharvest Handling of Organic Produce

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Compliance with National Organic Program (NOP) standards for postharvest chlorination has become a battle zone between packers on the one hand and certifiers and third-party auditors on the other. Wholesale and foodservice buyers of organic produce, both whole and minimally processed, have not taken a strong or consistent position regarding compliance with NOP restrictions on chlorine dose. A good deal of confusion has developed over varying perspectives regarding the interpretation of comments embodied in the National Organic Substances List regarding the absolute dose limits, monitoring, and measurement of chlorine residual compounds in organic postharvest handling and minimal processing (fresh-cut produce) operations.

The focus of the debate revolves around whether to measure chlorine concentrations

- at the point of contact with the edible product
- immediately downstream from each point of treatment
- at the point of final effluent discharge or recapture for circulation and reuse

The only clear point of agreement among packers, shippers, minimal processors, certifying agents, and audit inspectors is that measurement at the point of injection or treatment is not crucial for compliance, although some buyers specify an upper limit of total chlorine in order to minimize concerns about the development of chlorinated disinfection by-products due to their negative health and environmental impacts.

The current NOP standard specifies a maximum of 4 ppm of chlorine residuals downstream. Rancorous argument has often led to inconsistent application of the NOP rule. Though not documented, auditors may apply different criteria for different operations.

WHY IS CHLORINE A CONCERN?

Chlorinated compounds in particular, and other common sanitizing halogens as well, have been shown to produce disinfection by-products (DFB), including trihalomethanes. Trihalomethanes are a class of compounds that have known or suspected detrimental effects on humans and wildlife. DFBs are more likely to be formed if there is a high organic component in the total soluble fraction and total suspended fraction of the water. The combined organic and inorganic load represents the "chlorine demand" of the water that must be oxidized before a residual of free chlorine can be detected. Chlorine demand is a broad term for oxidizable substrate and should not be confused with or used interchangeably to refer to pathogen contamination. Under poorly managed systems, excessive doses of chlorine are applied to water; these doses are more likely to result in undesirable DFB residuals on shipped produce, or undesirable DFB concentrations released to the environment in the waste stream without exceeding the 4 ppm limit. Those at greatest risk in these cases may be the packing

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shed workers or food handlers themselves. Regardless, very few would disagree that chlorine is a sanitizing tool that should be allowed in the safe handling of organic food due to legitimate and serious concerns for public health and safety.

MATERIALS AND LEVELS ALLOWED

Sodium hypochlorite, calcium hypochlorite, and chlorine dioxide are allowed for use in postharvest handling and processing. Residual chlorine levels (the amount measurable after all oxidative reactions have occurred) for wash water in direct contact with fresh produce (whole, trimmed, or fresh-cut) cannot exceed the maximum residual disinfectant limit under the Environmental Protection Agency (EPA) Safe Drinking Water Act. The maximum residual disinfectant level is defined by the EPA as the highest level of a disinfectant allowed in drinking water (currently 4 mg/L = 4 ppm; expressed as Cl_2).

Provisions in the NOP allow for chlorine materials to be used as algicides, disinfectants, and sanitizers in organic crop and handling operations. As an aid in washing, transport, and cooling, the residual chlorine levels allowed by the NOP are consistent with criteria included in the Safe Drinking Water Act for the use of chlorine and mandated documentation of such use in certified operations. The NOP also adopted EPA standard methods to define the sampling protocol to be used by accredited organic certifying agents when monitoring the maximum residual disinfectant limit for chlorine materials.

The following three points summarize the NOP position.

- Residual chlorine levels at the point where the wastewater stream leaves the production or handling operation must meet the limits defined by the Safe Drinking Water Act (4 mg/L).
- Accredited certifying agents must monitor the discharge or effluent point to ensure that certified operators are meeting the 4 mg/L limit.
- Levels of chlorine applied as a water additive for the purpose of disinfecting tools, equipment, food contact surfaces, or the edible product may be higher than 4 mg/L and should be at levels sufficient to control microbial contaminants. The chlorine dose at the beginning of any applicable water cycle in an organic operation is not limited to 4 mg/L.

To achieve their desired disinfection objectives, some packers freely interpret the discharge point of a flume water wash operation to be the point of discharge of the water either to a municipal sewer system or to an onsite effluent pond. To achieve compliance, in order to maintain certification status, determination of chlorine residuals is typically measured at the point of final combined, chlorinated and nonchlorinated, process wastewater discharge.

The NOP position for chlorine level compliance was intended to ensure that chlorine levels of water were adequate for the intended use and were consistent with achieving desired standards of Good Agricultural Practices (GAP), Good Handling Practices (GHP), and Good Manufacturing Practices (GMP). GAP and GHP are embodied in guidance documents, and are therefore not mandatory and not regulated per se. GMP (more properly current GMP or cGMP) are mandatory programs, regulated and enforced by the U.S. Food and Drug Administration (FDA) for all food processing facilities. Depending on the specific methods of handling and extent of postharvest processing, horticultural crops (fruits, vegetables, nuts, seed sprouts, mesclun blends, mini-greens, herbs, edible flowers, etc.) may be subject to mandatory GMP standards. The specific transition point from being classified, for regulatory purposes, from a handler of a raw agricultural commodity to a food processor is particularly blurred.

More ardent proponents of organic food handling take a very different position from the NOP and GAP guidance for organic producers and handlers: they favor requiring that the chlorine level in water immediately before it contacts produce must never exceed the 4 ppm threshold. They argue that the concentration of free chlorine in water that contacts organic food is the only literal and relevant criteria for compliance with organic standards. The most literal interpretation is that chlorine materials should be used only for disinfecting and sanitizing food contact surfaces, and chlorinated water is otherwise prohibited from direct contact with raw or minimally processed produce. Further, wastewater discharge residuals are independent criteria for certification, both for minimizing negative environmental impacts and for maintaining compliance if treated and recirculated or reclaimed water is used to irrigate land in certified organic production.

Using chlorinated sanitizers to disinfect contact surfaces in packing shed or value-added processing facilities is a different issue. There is no upper chlorine limit for cleaning equipment, but the effluent from equipment and food contact surface sanitizing operations must still be managed and measured before discharge in order to maintain compliance. Certifiers typically require an intervening surface rinse with potable water to ensure that organic products are not subsequently affected by surface contact during grading and sorting, packing or filling, or size reduction (trimming, cutting, dicing, and slicing).

CHLORINE ALTERNATIVES

While hypochlorite, generally in liquid sodium forms, remains the least expensive overall and most commonly used oxidizer, recent research has shown that liquid sodium forms are not always the best choice for water disinfection and control of decay- or spoilage-causing microbes and pathogens of produce. Alternative water disinfection methods, including UV, ozone, hydrogen peroxide, and peroxyacetic acid, may be more suitable, and several formulations are approved and listed by the Organic Materials Research Institute (OMRI), a nonregulatory organization that maintains the generally recognized, but not fully authoritative, list of allowed, restricted, and prohibited materials.

MONITORING

Chlorine levels may be monitored for compliance by several means. The most accurate and practical approach is to use chlorine sensors, which are available from several suppliers. Residual-chlorine sensors are mounted in a constant flowcell, receiving process water through a bypass loop, and indirectly measure levels of hypochlorous acid (HOCl) by small changes in current across the probe during controlled electrolysis. More advanced sensors also measure pH and automatically compensate the readings to reflect projected HOCl concentrations. Typical sensitivity ranges are from 0.01 to 5 mg/L and 0.05 to 20 mg/L, sufficient to monitor levels for both process management and compliance documentation. At this time, no independent, comparative performance data in postharvest handling associated with a specific supplier or model is available.

SUMMARY

Shippers, repackers, handlers, inspectors, and certifiers are currently making different value judgments about the suitability of chlorine as a treatment, rather than making different interpretations of the NOP standards for postharvest chlorination. Interpretations of these standards should be consistent with the need to protect the integrity of an Organic Farm and System Plan. The current situation promotes

nonuniform application of the NOP rule, and therefore, at a real level, undermines the industry's efforts to sustain consumer confidence that "USDA Certified Organic" items meet their expectations.

As it appears unlikely that the issue will be resolved in the near future, the following Recommended Management Practices are based on a balanced approach to enhancing quality and safety. The greater risk of microbial food safety concerns is recognized as a higher priority than uncharacterized health concerns associated with the potential formation of disinfection by-products.

RECOMMENDED STEPS TO OPTIMIZE POSTHARVEST CHLORINATION

1. Minimize all sources of chlorine demand on incoming product.
2. Inspect incoming product during precooling staging for excessive amounts of soil adhering, damaged product, and nonproduct plant material (such as leaf or vine trash). Remove as practical.
3. Provide feedback as needed to harvest operations or crews to improve performance in reducing sources of chlorine demand at the field level.
4. For products that will tolerate it, vigorous mechanical cleaning (such as brushing or high-pressure washing) may significantly reduce chlorine demand and extend the clarity of the process water and the functional disinfection activity.
5. Manage postharvest water to maintain a pH of 6.5 to 7.0 and a level of free chlorine necessary to achieve disinfection goals while not exceeding 4 ppm, measured at the point the product is removed from that operational step. For example, adjust chlorine level in dump and flume tank injection water to maintain 50 ppm; maintain chlorine level in recirculating water at 4 ppm or less at the return sump (the furthest point from injection, as product transfers to a lift conveyor).
6. For products that will tolerate it, heating chlorinated water increases effectiveness in disinfection. This must be balanced, however, with reduced stability and increases in irritating "off-gassing." Heating initial receiving water above the temperature of incoming product also minimizes the potential for water infiltration to the product.
7. If necessary, add approved flocculants to capture suspended sediments in water and hold the water in a retention sump basin. Screen and filter recirculating water to reduce chlorine demand.
8. Dump and flume tank, hydrocooler sump basins and, any sediment collection points in equipment must be cleaned daily. Sediments are a common reservoir for decay pathogens and pathogens of concern for human food safety.
9. Develop a system of periodic partial or full turnover to clean water that balances the cost and time delays of cooling (or heating) postharvest water with the goal of minimizing the turbidity and conductivity (salt buildup) of the water.
10. Ensure that responsible personnel are trained in the function and operation of equipment and monitoring kits. Define the timing, frequency, and procedures to be used in monitoring in a Standard Operating Procedure (SOP) for each product line.
11. Ensure that responsible personnel are trained to implement and document any corrective actions that must be taken to meet product quality and safety needs within NOP standards.

ADDITIONAL INFORMATION AND RESOURCES

ATTRA—National Sustainable Agriculture Information Service Web site, http://www.attra.org/.

California Organic Program Web site, http://www.cdfa.ca.gov/is/fveqc/organic.htm.

National Organic Program (NOP) Web site, http://www.ams.usda.gov/nop/indexIE.htm.

National Organic Standards Board (NOSB) Web site, http://www.ams.usda.gov/nosb/index.htm.

Organic Materials Research Institute (OMRI) Web site, http://www.omri.org/.

UC Organic Vegetable Production Series Web site, http://vric.ucdavis.edu/selectnewtopic.organic.htm.

UC Food Safety Online Resource Web site, http://ucfoodsafety.ucdavis.edu.

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