Use of Chlorine Materials in Organic Production & Handling
NOP Technical Evaluation Report Summary

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The National Organic Program (NOP) has issued NOP 5026 “Guidance, the use of Chlorine Materials in Organic Production and Handling.” This guidance document clarifies the use of chlorine materials in organic production and handling to align the National List with the November, 1995 NOSB recommendation on chlorine materials which read:

“Allowed for disinfecting and sanitizing food contact surfaces. Residual chlorine levels for wash water in direct crop or food contact and in flush water from cleaning irrigation systems that is applied to crops or fields cannot exceed the maximum residual disinfectant limit under the Safe Drinking Water Act (currently 4 ppm expressed as Cl2).”

Specific Uses of the Substance:

Electrolyzed water has received recent attention as an alternative to other chlorine disinfectants and sanitizers. A number of studies have demonstrated the strong antibacterial activity of electrolyzed water against foodborne pathogens on raw agricultural products and food contact surfaces. Applications of electrolyzed water as a disinfectant for reducing microbial contamination have been reported for fresh fruits and vegetables, poultry carcasses, shell eggs, cutting boards, and food processing surfaces. Some advantages of using electrolyzed water are: 1) Electrolyzed water is as effective as any chlorine treatment, 2) it is not necessary to handle potentially dangerous chemicals, e.g. chlorine gas, chlorine dioxide, bleach, 3) the apparatus to produce electrolyzed water is relative inexpensive and easy to operate, 4) because only water and sodium chloride are used electrolyzed water production is environmentally friendly and 5) the properties of the electrolyzed water can be controlled at the preparation site (Su et al., 2007). In addition to its microbiocidal action on actively growing bacteria, electrolyzed water is known to kill bacterial spores by damaging their inner membrane rendering them unable to germinate.

Electrolyzed water has been reported to have strong bactericidal effects on many pathogenic bacteria, such as Escherichia coli O157:H7, Listeria monocytogenes, and Salmonella species (Kim et al., 2000). Suppression of fruit rot in pears caused by the fungus Botryosphaeria berengeriana was observed after dipping fruit in an electrolyzed water solution for as little as 10 minutes (Al-Haq et al., 2002).

Electrolyzed water quickly kills a variety of fungi and shows promise as a broad-spectrum contact fungicide for control of foliar diseases of greenhouse-grown ornamentals. One requirement for use in the greenhouse is that electrolyzed water will

not cause excessive phytotoxic symptoms on a wide variety of species. Electrolyzed water causes slight damage to some plant species but, in general, appears to be safe to use as a foliar spray on a wide variety of bedding plants grown under greenhouse conditions. Such applications may be useful in reducing bacterial contamination resulting from insect scale and known arthropod plant disease vectors (Buck et al., 2003).

Approved Legal Uses of the Substance:

The Environmental Protection Agency (EPA, 2014) registers all sanitizers and disinfectants as pesticides. However, onsite electrolyzed water devices (generators) that use sodium chloride and water to produce antimicrobial substances are not required to be registered as a pesticide.

Pesticide Chemical: Hypochlorous acid
CAS No.: 7790-92-3
Limits: When ready for use, the end-use concentration of all hypochlorous acid chemicals in the solution is not to exceed 200 ppm determined as total available chlorine.

The Food and Drug Administration (FDA) regulations (21 CFR Part 178) permit the use of sanitizing solutions containing sodium hypochlorite on food processing equipment and food contact surfaces. The active ingredients in these solutions are the chlorine oxidants hypochlorous acid, hypochlorite ion and free chlorine:

The following provisions must be followed:
1) Equipment or articles sanitized with the solution must be allowed to drain adequately before contact with food.
2) Solutions used for sanitizing equipment shall not exceed 200 parts per million (ppm) of available chlorine.

In addition to sanitizing food contact surfaces, cleaning solutions containing the active ingredient hypochlorous acid may be used for sanitizing raw fruits and vegetables during the washing or peeling process. The federal regulations that apply differ slightly from those for sanitizing solutions.

The regulations (21 CFR §173.315 - Chemicals used in washing or to assist in the peeling of fruits and vegetables) specify two conditions for the permitted use of hypochlorite solutions in washing produce:

1) The concentration of sanitizer in the wash water must not exceed 200 ppm hypochlorite.
2) The produce must be rinsed with potable water following the chlorine treatment.
3) Contact times of one minute or greater are typically sufficient to achieve a thorough kill.
4) Any chlorine ingredient that is used for making a sanitizing solution, whether for

equipment or raw produce, must be of sufficient purity to be categorized as a food grade substance.

FDA's Food Code (FDA, 2013) states that chemical sanitizers, including chemical sanitizing solutions generated on-site, and other chemical antimicrobials applied to food contact surfaces shall (chapter 7-204.11 of the Food Code):

(A) Meet the requirements specified in 40 CFR 180.940 tolerance exemptions for active and inert ingredients for use in antimicrobial formulations (Food-contact surface sanitizing solutions) or
(B) Meet the requirements as specified in 40 CFR §180.2020 pesticide chemicals not requiring a tolerance or exemption from tolerance-non-food determinations.

The criteria for chemicals for washing, treatment, storage and processing fruits and vegetable are stated in chapter 7-204.12 of the Food Code:

(A) Chemicals*, including those generated on-site, used to wash or peel raw, whole fruits 218 and vegetables shall:
(2) Be generally recognized as safe (GRAS) for this intended use, or
(3) Be the subject of an effective food contact notification for this intended use (only effective for the manufacturer or supplier identified in the notification), and
(4) Meet the requirements in 40 CFR 156, Labeling Requirements for Pesticide and Devices.

The USDA's Food Safety and Inspection Service Directive 7120.1 "Safe and Suitable Ingredients Used in the Production of Meat and Poultry Products", has approved the use of electrolytically generated hypochlorous acid as a food additive for use on meat and poultry products. It is allowed for use on red meat carcasses down to a quarter of a carcass, whole or eviscerated poultry carcasses, in water used in meat and poultry processing, in poultry chiller water, for reprocessing contaminated poultry carcasses, on giblets and salvaged parts, and on beef primal cuts of beef. Depending on the product sanitized from 5 to 50 ppm free available chlorine can be used.

USDA's "Regulations Governing the Voluntary Grading of Shell Eggs" explains the minimum facility and operating requirements for shell egg grading and packing plants regarding shell egg cleaning operations. This includes specific temperature requirements for washing and rinsing eggs as well as the chlorine sanitizer that will be used (USDA, 2008).

Organic Foods Production Act, USDA Final Rule:
Known as electrolyzed water, hypochlorous acid is a synthetic substance not found on the National List of Allowed and Prohibited Substances (§7 CFR205.600-606) for production and handling of organic products. This solution is generated by the electrolysis of a diluted water sodium chloride solution passing through on electrolysis

chamber (Fig 1). This electrolytic process facilitates the conversion of chloride ions and water molecules into chlorine oxidants (chlorine gas, hypochlorous acid, and hypochlorite ion). When used in accordance with good agricultural practice, electrolyzed water can be used as an effective and environmentally friendly sanitizing solution.

Table 3. Disinfection methods with their advantages and disadvantages

Treatment	Advantages	Disadvantages
Sodium hypochlorite Calcium hypochlorite Chlorine dioxide Acidified Sodium Chlorite	Chlorine based disinfectants, very effective at killing most microorganisms including spores. Liquids best used at pH 6.5-7.5.	After use concentration must be less than 4 ppm. Can damage products at high concentrations. Issues with humic acids.
Ozone	Effective disinfectant kills rapidly.	Must be produced on site, harmful to humans. Not approved for organic production and handling.
Irradiation	Very effective disinfectant.	May affect sensory qualities of products, harmful to humans. Ionizing radiation is not permitted in organic production.
Hydrogen Peroxide (H_2O_2)	Potential as disinfectant.	Affects sensory qualities of some products, harmful to humans and not applicable to all products.
Organic Acids	Effective alone or in combination with other sanitizers, simple products such as lemon juice, or vinegar may be used.	Not useful for all products, may have adverse effects on sensory qualities, may lead to loss of germination percentage when used on seeds.
Essential Oils	Most effective for gram positive bacteria.	Gram negative bacteria are more resistant, adverse sensory effects.
High Temperatures	Successful disinfection method.	Not applicable to all products consumed raw.
Biocontrol and non-thermal process	Not well tested in fruit and vegetable products.	High cost, not enough research.