Electrolyzed Water

WAEW maintains bactericidal activities against V. parahaemolyticus under open storage conditions even after 5 weeks and could be used as a postharvest treatment to reduce Vibrio contamination in oysters.

From: Encyclopedia of Food Safety, 2014

Related terms:

Inactivation, Microorganisms, Disinfection, Electrolysis, Shelf Life, Salmonella, Lettuce

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Electrolyzed Water Application in Fresh Produce Sanitation

Setareh G. Shiroodi, Mahmoudreza Ovissipour, in Postharvest Disinfection of Fruits and Vegetables, 2018

9 Future of Electrolyzed Water

Electrolyzed water applications in different sections have already been proved. It appears electrolyzed water has the potential for being used as one of the useful sanitizers in food, aquaculture, agriculture, medical, and energy industry. Recently, many start-up companies and industries started commercialization and marketing of different types of electrolyzed water all around the world.

There are many companies worldwide that have been established for producing pure electrolyzed water solutions with different chlorine concentrations for different applications. For example, AquaOx LLC in the United States is producing two types of electrolyzed water with different hypochlorous acid concentrations which have been tested in food plants and for medical applications. Additionally, this company is using these solutions for treating plant diseases by spraying them on the trees. It seems in near future electrolyzed water could be sold in stores for using as home sanitizer. The small electrolyzed water machines are also available which could be installed in restaurant and medicals offices for the sanitation and disinfection of contact surfaces and instruments.

The use of electrolyzed water for treating plant disease or in aquaculture for sanitizing and treating pathogenic microorganism can provide pesticide-free and drug-free fresh products for human consumption. Furthermore, electrolyzed water impacts on wound healing and its wound sanitation application have been approved, there are several companies that produce diluted hypochlorous acid for wound treatment.

It has become clear that electrolyzed water is one of the promising sanitizers for future, which can provide pesticide- and drug-free food products.

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Biological Emerging Risks in Foods

Walter Randazzo, ... Gloria Sanchez, in Advances in Food and Nutrition Research, 2018

5.4.2 Electrostatic Sprays/Electrolyzed Water

Electrolyzed water (EOW)'s exact mechanism of antiviral action remains unclear (Tian, Yang, & Mandrell, 2011). Acidic EOW wash was shown to incrase the binding of HNoV to raspberries and lettuce, causing removal of only ~ 7.5% and ~ 4%, respectively (Kingsley & Chen, 2008). A recent study showed that neutral EOW at 250 ppm free available chlorine caused a 4.8 and 0.4 log reduction in HNoV genome copy numbers after 1 min in suspension and on stainless steel, respectively (Moorman, Montazeri, & Jaykus, 2017).

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Interventions to Reduce Shiga Toxin–Producing Escherichia coli on Beef Carcasses at Slaughter

Corliss A. O'Bryan, ... Philip G. Crandall, in Food and Feed Safety Systems and Analysis, 2018

Electrolyzed Water

Electrolyzed water (EW) is emerging as an environmentally friendly antimicrobial treatment (Huang et al., 2007). It is produced by electrolysis of a dilute salt solution, and the reaction products include sodium hydroxide (NaOH) and hypochlorous acid (Huang et al., 2007). Three forms of the solution can be produced, an acidic form, a neutral pH form, and an alkaline form. Acidic EW exhibits an acid pH, a high oxidation reduction potential, and high free chlorine concentrations which makes it effective as an antimicrobial agent (Kim et al., 2000a,b; Hsu, 2003). Researchers have found EW able to control *E. coli* O157:H7 on various vegetables (Hung et al., 2010; Pangloli et al., 2009; Venkitanarayanan et al., 1999). Jadeja et al. (2013) used in vitro testing to determine that *E. coli* O26, O45, O103, O121, O111, and O145 were as susceptible to EW as was *E. coli* O157:H7. They also determined that EW was more active against the STEC than sodium hypochlorite at the same free chlorine concentration. In the United States, EW is allowed on beef carcasses applied as a spray at a level not to exceed 50 ppm calculated as free available chlorine (USDA/FSIS, 2014).

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Combining sanitizers and nonthermal processing technologies to improve fresh-cut produce safety

C.J. Doona, ... K. Kustin, in Electron Beam Pasteurization and Complementary Food Processing Technologies, 2015

7.7 Electrolyzed water (EW) sanitizer

EW has been shown as a viable alternate disinfection tool for wash water (Ongeng *et al.*, 2006). Gil *et al.* (2009) cited the Ecodis® technology for its use of anodic oxidation principles in the technology that consists of a highly efficient electrolysis cell equipped with coated permanent titanium electrodes. A direct low-voltage current passes across the electrodes through an NaCl solution and causes the formation of potent oxidizing radicals derived from oxygen and chloride that react to form hypochlorous acid and hypochlorite ions. The anode produces acidic EW with a pH of around 2.5 or less, and potent antibacterial activity against a number of pathogens.

The effects of acidic EW was demonstrated by a number of researchers to decontaminate surfaces of lettuce, tomatoes, strawberries, apples, cantaloupes, and cucumbers (Koseki *et al.*, 2001; Bari *et al.*, 2003; Koseki *et al.*, 2004; Guentzel *et al.*, 2008). Acidic EW was also effective for the inactivation of *E. coli* O157:H7, Salmonellaspp., *L. monocytogenes* and Bacillus ceretis on the surfaces of fresh produce as demonstrated by various researchers (Venkitanarayanan *et al.*, 1999; Kim *et al.*, 2000; Park *et al.*, 2001; Park *et al.*, 2008a,b). However, the effectiveness of acidic EW can be impacted by organic matter, which will affect its ability to inactivate pathogens on surfaces of produce items (Park *et al.*, 2008b). In another study conducted by Kim *et al.* (2006), acidic EW was used to treat alfalfa and broccoli seeds. The acidic EW treatment at 55°C for 10 min, produced from an acidic EW generator using deionized water and 10% NaCl solution, resulted in a 3.4 and 3.3 log reduction of *E. coli* O157:H7 from alfalfa and broccoli seeds respectively and did not significantly impact the gemination rates of the seeds.

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Sanitization

C.P. Chauret, in Encyclopedia of Food Microbiology (Second Edition), 2014

Acidic Electrolyzed Water

Acidic electrolyzed water is produced using sodium chloride to yield sodium hypochlorite by electrolysis. Acidic electrolyzed water has a pH of about 2.5 and has been reported to be a strong and broad spectrum disinfectant for use on food-contact surfaces. It is not corrosive to skin or mucous membranes; however, it can be corrosive to certain metals. Studies have indicated that acidic electrolyzed water at 50 mg l^{-1} (available chlorine concentration) can reduce both Gram-positive and Gram-negative bacteria by more than 5 logs with 1 min of contact time. To achieve similar inactivation levels with a solution of sodium hypochlorite solution, a concentration of 120 mg l^{-1} was required, thus demonstrating the potential of acidic electrolyzed water.

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Novel technologies for the decont-amination of fresh and minimally processed fruits and vegetables

B.A. Niemira, in Case Studies in Novel Food Processing Technologies, 2010

11.2.1 Electrolyzed water (EW)

EW provides an effective antimicrobial treatment using only inexpensive, nonvolatile inputs: salt, water and electricity. When electricity is passed through a dilute aqueous saline solution, typically ~ 1% sodium chloride, the electrolyzed water yields an acidified stream rich in chloride ions, and a basic stream high in sodium ions (Koseki *et al*., 2004; Wang *et al*., 2006).

The antimicrobial efficacy of EW is related to concentration and exposure time, but also by conditions of exposure. Green onions and tomatoes inoculated with a 10^9 cfu/ml culture cocktail of Escherichia coli 0157:H7, Salmonella Typhimurium, or Listeria monocytogenes were rendered free of contamination (i.e. below detection limit) within 3 minutes of treatment with acidified EW (pH 2.06, free available chlorine concentration 37.5 ± 2.5 mg/l). However, under conditions of high organic material, the efficacy of the process was reduced (Park *et al*., 2008a). In associated studies, lettuce and spinach leaves were inoculated with a 10^8-10^9 cfu/ml cocktail of three strains of each *E. coli* 0157:H7, *Salmonella* Typhimurium and *L. monocytogenes*. As with green onions and tomatoes, treatment with acidic EW (pH 2.06, free available chlorine concentration 37.5 ± 2.5 mg/l) was similarly effective, reducing the pathogens to undetectable levels within 5 minutes, but only when the presence of organic material was low. As the presence of organic material increased, the bactericidal activity decreased (Park *et al*., 2008b). These results suggest that the most appropriate usage for EW is as a second wash/treatment step, after a primary wash had been effected to remove most of the associated organic material.

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Control Strategies for Postharvest Microbiological Safety of Produce During Processing, Marketing, and Quality Measures

Luis J. Bastarrachea, ... Rohan V. Tikekar, in Safety and Practice for Organic Food, 2019

3.2 Electrolyzed Water

Electrolyzed water is a relatively new concept that has attracted attention in recent years. To produce electrolyzed water, a sodium chloride solution (although potassium chloride may also be used) has to be passed through an electrolysis chamber. The dissociation of anions and cations results in the formation of a variety of chemical species such as hypochlorous acid, chlorine gas, hypochlorite ion, and hydrochloric acid at the anode's side (Gil et al., 2015; Meireles et al., 2016). These chemical species individually possess a powerful antimicrobial character, mainly as oxidants but also as acids, so in combination they can create an effective disinfectant. The main motivation behind the development of this concept derives from the problems related to the storage and handling of commonly used chlorine solutions (mainly in the form of sodium hypochlorite), such as toxicity and lack of stability (Gil et al., 2015). Electrolyzed water also offers several advantages such as its environmentally friendly character, lack of detrimental effect on surfaces (compared to chlorine compounds), lack of deleterious effect on the organoleptic properties of foods, and an approved status by the FDA to be used as a disinfectant at maximum concentrations of 200 ppm (FDA, 2014; Meireles et al., 2016).

In a recent work (Navarro-Rico et al., 2014), neutral and acidic neutralized water (at both concentrations, 70 or 100 ppm) was challenged against mesophilic bacteria, psychrophilic bacteria, enterobacteria, yeasts, and molds in broccoli. The produce was washed and stored for up to 20 days at 5°C. Sodium hypochlorite at 100 ppm was used as a positive control. Both modes of electrolyzed water proved to be more effective than the chlorine treatment in reducing microbial loads. Moreover, the phenolic contents of the broccoli were less affected by the electrolyzed water treatments. In another study (Abadias et al., 2008), neutralized electrolyzed water was challenged against *E. coli* O157:H7, *L. monocytogenes*, *Salmonella*, and *Erwinia carotovora* inoculated in lettuce. The biocidal efficacy of neutralized electrolyzed water with a chlorine content of 50 ppm was comparable to the effect given by sodium hypochlorite at 120 ppm (1–2 logarithmic cycles). In addition, no difference in the antimicrobial efficacy was found between different inoculation levels (5–7 log (CFU/mL)). According to a 2015 memorandum from USDA, electrolyzed water is a type of chlorine material allowed in organic production and handling.

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Disinfection of Contaminated Produce with Conventional Washing and Sanitizing Technology

Gerald M. Sapers Ph.D. (Emeritus), in The Produce Contamination Problem, 2009

Electrolyzed Water

Electrolyzed water (also known as electrolyzed oxidizing or EO water) has received much attention as a replacement for chlorine in sanitizing produce, although in principle, it represents an alternative means of generating hypochlorous acid (Izumi, 1999). Hypochlorous acid is formed at the anode during electrolysis of water containing some sodium chloride. Depending on the sodium chloride concentration, the available chlorine level can reach or exceed 100 ppm. If the electrolyzed water generator has a membrane separating the electrodes, highly acidic (pH < 3.0) water will be produced at the anode, and alkaline water (pH ≥ 11.0) will be produced at the cathode. Electrolyzed water is considered to be an effective sanitizing agent at low pH with an oxidation-reduction potential greater than 1000 mV, and it can be used as a cleaning agent at high pH with a redox potential less than 800 mV (Deza et al., 2003; Yang et al., 2003; Ozer and Demirci, 2006).

Electrolyzed water is highly effective in reducing the population of planktonic cells (Venkitanarayanan et al., 1999a), but like chlorine, its efficacy in reducing bacterial populations attached to produce surfaces is generally limited to 1 to 3 logs (Izumi, 1999; Park et al., 2001). Other studies have yielded population reductions between 1 and 7 logs, depending on the commodity, method of inoculation and recovery, inoculation site, interval between inoculation and treatment, method of treatment, and strength of electrolyzed water (Koseki et al., 2003, 2004; Yang et al., 2003; Deza et al., 2003; Bari et al., 2003). It is questionable whether some of the larger reductions in attached microbial populations can be realized in a packing or processing plant situation.

> Read full chapter

Disinfection of Contaminated Produce with Conventional Washing and Sanitizing Technology

Gerald M. Sapers, in The Produce Contamination Problem (Second Edition), 2014

Electrolyzed water

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