Table of Contents

1 Hospitals including Dental and Foot Health


1.1.2 In-use effect of electrolysed water on transcutaneous oxygen sensors Stephanie J. Dancer · Julie Mallon · Rebecca Murphy · Cliff Murch ........................................----------10

1.1.3 Hypochlorous Acid - Analytical Methods and Antimicrobial Activity Müjde Eryilmaz* and Ismail Murat Palabiyik 2Department of Pharmaceutical Microbiology, 2Department of Analytical Chemistry, .................................................................10

1.1.4 Hypochlorous Acid: an ideal wound care agent with powerful microbicidal, antibiofilm, and wound healing potency. Sakarya S1, Gunay N2, Karakulak M3, Ozturk B4, Ertugrul B4. ...........................................10

1.1.5 Comparison of cleaning efficacy between in-use disinfectant and electrolysed water in an English residential care home N.S. Meakin · C Bowman · M.R. Lewis · S.J. Dancer ...........................................................................10

1.1.6 Efficacy and Safety of neutral pH Super-Oxidized Solution in SEVERE Diabetic Foot Infections ..............................................................................11


1.1.9 An investigation of the efficacy of super-oxidised water for the disinfection of dental unit water lines. M V Martin1 & M A Gallagher 12

1.1.10 Ultrasonically nebulised electrolysed oxidising water: A promising new infection control programme for impressions, metals and gypsum casts used in dental hospitals Articlen Journal of Hospital Infection 68(4):348-54 · April 2008 DOI: 10.1016/j.jhin.2008.01.02 ..........12


1.1.12 Absolute rate constants for the reaction of hypochlorous acid with protein side chains and peptide bonds. Pattison D1, Davies MJ. Chem Res Toxicol. 2001 Oct;14(10):1453-64 ..................................................................................12

1.1.13 Hypochlorous Acid as a Potential Wound Care Agent Part I. Stabilized Hypochlorous Acid: A Component of the Inorganic Armamentarium of Innate Immunity L Wang, PhD,a M Bassiri, PhD,a R Najafi, PhD,a K Najafi, MD,b j Yang, BS,a B Khosravi, PhD,a W Hwang, BS,a E Barati, BS,a B Beilis, PhD,a C Celeri, MS,a and MC Robson, MDC ...........................................................................13


1.1.15 Acidic Electrolysed Water in the Disinfection of the Ocular Surface Shigeto Shimamura · Koki Matsumoto · Hiromoto Yaguchi · Kazuo Tsubot ..........................................................13


1.1.20 Super-Oxidized Solution (SOS) Therapy for Infected Diabetic Foot Ulcers ..................................................................................14

1.1.21 Non-surgical Management of Chronic Wounds in Patients With Diabetes ..................................................................................14

1.1.22 A pilot study on microbial load reduction in peritonitis with a neutral pH – super-oxidized solution ........................................................................14

1
1.1.23 Neutral Super-Oxidised Solutions Effective in killing P. aeruginosa biofilms ................................................................. 14

1.1.24 Comparative Efficacy and Tolerability of Microcyn Super-Oxidize Solution (Oxum) against Povidone Iodine Topical Application in the Post-caesarean Section Wound Management .................................................................................................................. 15


1.1.26 Diabetic Micro-Vascular Complication Today .................................................................................................................. 15

1.1.27 A Novel Super-Oxidized water with neutral pH and Disinfectant activity ........................................................................ 15

1.1.28 Treatment of Diabetic Foot Ulcer: An Overview of Strategies for Clinical Approach .................................................... 15

1.1.29 Super-Oxidized Solution inhibits IgE-antigen-induced degranulation and cytokine release in mast cells .................... 15

1.1.30 An evaluation of one test product for its antimicrobial properties when challenged with various micro-organism strains using an in-vitro time-kill method ............................................................................................................................................................ 15

1.1.31 Panel Intelligence Report - Diabetic Foot Infection Treatment .......................................................................................... 15


1.1.34 Bongiovanni, CM, Superoxidized Water Improves Wound Care Outcomes in Diabetic Patients; Diabetic Microvascular Complications Today, 2006, May-June: 11-14................................................................................................................................................................................................................................................................................................ 16


3 Biofilms .................................................................................................................................................................19

4 Biofilms ..................................................................................................................................................................19

2 Veterinary ..............................................................................................................................................................17

3 Food Industry General .............................................................................................................................................17

2 Ready to Eat Meals ....................................................................................................................................................18

3 Surfaces and Cutting Boards ..................................................................................................................................18

3.3.1 Efficacy of Low Concentration Neutralised Electrolysed Water and Ultrasound Combination for Inactivating Escherichia coli ATCC 25922, Pichia pastoris GS115 and Aureobasidium pullulans 2012 on Stainless Steel CouponsLin Zhao - Ying Zhang - Hongsun Yang ..........................18


3.3.7 Effectiveness of electrolyzed water as a sanitizer for treating different surfaces. Park, H., Y.-C. Hung, and C. Kim. 2002. J. Food Prot. 65:1276–1280. .................................................................19


1.1.51 Stuttgart Congress 2005 (various papers) ..............................................................................................................16


2 Veterinary ..............................................................................................................................................................17


3 Food Industry General .............................................................................................................................................17


3.1.2 Application of electrolyzed water for food industry in Japan. Yoshida, K., N. Achiwa, and M. Katayose. 2004. ................................................................................................................17

3.1.3 Efficacy of electrolyzed oxidizing (EO) and chemically modified water on different types of foodborne pathogens. Kim, C., Y.-C. Hung, and R. E. Brackett. 2000. Int. J. Food Microbiol. 61:199–207. ................................................................................................................17

3.1.4 Cleaning in place with onsite-generated electrolysed oxidizing water for water-saving disinfection in breweries Lu Chen - Rong Chen - Huay Yin - [.] - Hong Lin ................................................................................................................17


3.2 Ready to Eat Meals ....................................................................................................................................................18


3.3 Surfaces and Cutting Boards ..................................................................................................................................18

3.3.1 Efficacy of Low Concentration Neutralised Electrolysed Water and Ultrasound Combination for Inactivating Escherichia coli ATCC 25922, Pichia pastoris GS115 and Aureobasidium pullulans 2012 on Stainless Steel CouponsLin Zhao - Ying Zhang - Hongsun Yang ..........................18


3.3.7 Effectiveness of electrolyzed water as a sanitizer for treating different surfaces. Park, H., Y.-C. Hung, and C. Kim. 2002. J. Food Prot. 65:1276–1280. ................................................................................................................19
5.1 General ........................................................................................................................................................................ 20

5.2 Fruit .............................................................................................................................................................................. 20

5.3 Strawberry ................................................................................................................................................................. 20

5.4 Peach ............................................................................................................................................................................... 21

5.5 Pear ................................................................................................................................................................................ 21

5.6 Apples ............................................................................................................................................................................. 21

5.7 Figs .................................................................................................................................................................................. 21

5.8 Cut Vegetables ............................................................................................................................................................. 21


5.9 Tomatoes........................................................................................................................................................................................... 22


5.9.4 Fate of foodborne pathogens on green onions and tomatoes by electrolyzed water E-J. Park· E Alexander· G.A. Taylor [……] D-H Kang 23

5.10 Flowers ........................................................................................................................................................................................................ 23


5.11 Cucumber .................................................................................................................................................................................................. 23


5.12 Lettuce .................................................................................................................................................................................................. 23


5.13 Alfalfa seeds .................................................................................................................................................................................................. 24


5.14 Rice ........................................................................................................................................................................................................ 24


5.15 Tofu ........................................................................................................................................................................................................ 24

6 Animals

6.1 General agriculture and food...

6.2 Cattle & Beef

---

**Wheat noodles**


6 Animals

6.1 General agriculture and food...

6.2 Cattle & Beef

---


6.2 Cattle & Beef

---


6.2 Cattle & Beef

---


6.3 Pigs and Pork

---


6.4 Poultry - Chickens

---


6.4.11 Evaluation of “Neutral Electrolyzed Water” Disinfectant on Inactivation of Avian Influenza Virus and Other Avian Viruses .......... 28


6.5 Fish and Seafood................................................................................................................................................................. 28


7 Disinfection and general properties ................................................................. 30

7.1 General ................................................................................................................................................................. 30


7.1.6 Different responses of planktonic and attached Bacillus subtilis and Pseudomonas fluorescent to sanitizer treatment. Lindsay, D., and A. von Holy. 1999. J. Food Prot. 62:368–379 ........................................................................................................................................ 31
7.1.7 Decontamination of aflatoxin-forming fungus and elimination of aflatoxin mutagenicity with electrolyzed NaCl anode solution.


7.1.29 Investigation of the presence of OH radicals in electrolyzed NaCl solution by electron spin resonance spectroscopy. Stan SD, Woods JS, DaeschelMA. Department of Food Science and Technology, Oregon State University, 100 Wiegand Hall, Corvallis, Oregon 97331, USA. .................................................................36
1 Hospitals including Dental and Foot Health

Objective: To investigate the effect of electro-chemically activated water on biofilm contamination in dental unit water lines.
Design: Thirteen dental units fitted with independent water systems and used for 12 years with distilled water were divided into two groups, A and B. At the start, one week later, and again four weeks later, the bacterial counts in water from all units were determined. Also specimens of tubing were taken from the units at the beginning and at the end of the study for SEM investigation. In Group A distilled water was replaced with electrochemically activated water (a Russian invention), and used continuously for the duration of the study. In group B, distilled water was used as before, until confirmed to be contaminated. For ethical reasons group B was treated, one week into the study with conventional disinfectants.
Setting: The project was carried out in a clinic of a department of periodontology of a faculty of dentistry during 1998.
Results: Both groups showed a marked reduction in bacterial counts. Under SEM Group A showed a total elimination of the biofilm and Group B a partial removal.
Conclusions: Distilled water was ineffective in controlling bacterial counts and biofilm. Electrochemically activated water was effective for this purpose.
Source: British Dental Journal

1.1.2 In-use effect of electrolysed water on transcutaneous oxygen sensors Stephanie J. Dancer · Julie Mallon · Rebecca Murphy · Cliff Murch Reusable clinical equipment should be decontaminated between patients in order to reduce risk of pathogen transmission. Manufacturers are obliged to offer advice regarding decontamination but occasionally insufficient guidance is provided. Tissue oxygen sensors are reusable, costly and vulnerable to disinfectants. This pilot study describes an in-use protocol using neutral electrolysed water aimed at eliminating infection risk during transcutaneous oxygen monitoring of diabetic feet. Sensor components were screened for microbial contamination before, during, and after monitoring healthy and diabetic volunteers. Exposure to electrolysed water removed original skin commensals and alleviated the risk of transmitting microbial flora without affecting test results. The product is non-toxic, inexpensive and may be useful for decontaminating a wide range of sensitive clinical equipment.
© Australasian College for Infection Prevention and Control 2015.

1.1.3 Hypochlorous Acid - Analytical Methods and Antimicrobial Activity Müjde Eryılmaz1* and İsmail Murat Palabiyık2 1Department of Pharmaceutical Microbiology, 2Department of Analytical Chemistry,
Hypochlorous acid (HOCl), a powerful oxidizer and deproteinizer produced by neutrophils, has a good microbial activity within these cells. It reacts with many biological molecules, especially thiol, thioether, heme proteins, amino groups and carbohydrates, as well as overcomes pathogens and fights infection [1-3]. HOCl has advantages over sodium hypochlorite (NaOCl) and hydrogen peroxide (H2O2) in that within its effective antimicrobial concentration range, it is non-irritating, non-sensitizing and cytotoxicity to mammalian cells is lower.
Source: Paper

1.1.4 Hypochlorous Acid: an ideal wound care agent with powerful microbicidal, antibiofilm, and wound healing potency. Sakarya S1, Gunay N2, Karakulak M3, Ozturk B4, Ertragul B4. Chronic wounds and the infections associated with them are responsible for a considerable escalation in morbidity and the cost of health care. Infection and cellular activation and the relation between cells are 2 critical factors in wound healing. Since chronic wounds offer ideal conditions for infection and biofilm production, good wound care strategies are critical for wound healing. Topical antiseptics in chronic wounds remain in widespread use today. These antiseptics are successful in microbial eradication, but their cytotoxicity is a controversial issue in wound healing.
OBJECTIVE: The aim of this study was to investigate the effect of stabilized hypochlorous acid solution (HOCI) on killing rate, biofilm formation, antimicrobial activity within biofilm against frequently isolated microorganisms and migration rate of wounded fibroblasts and keratinocytes.
MATERIALS AND METHODS: Minimal bactericidal concentration of stabilized HOCI solution for all standard microorganisms was 1/64 dilution and for clinical isolates it ranged from 1/32 to 1/64 dilutions.
RESULTS: All microorganisms were killed within 0 minutes and accurate killing time was 12 seconds. The effective dose for biofilm impairment for standard microorganisms and clinical isolates ranged from 1/32 to 1/16. Microbicidal effects within the biofilm and antibiofilm concentration was the same for each microorganism.
CONCLUSION: The stabilized HOCI solution had dose-dependent favorable effects on fibroblast and keratinocyte migration compared to povidone iodine and media alone. These features lead to a stabilized HOCI solution as an ideal wound care agent.

1.1.5 Comparison of cleaning efficacy between in-use disinfectant and electrolysed water in an English residential care home N.S. Meakin · C Bowman · M.R. Lewis · S.J. Dancer
Infection control in hospitals and care homes remains a key issue. They are regularly inspected regarding standards of hygiene, but visual assessment does not necessarily correlate with microbial cleanliness. Pathogens can persist in the inanimate environment for extended periods of time. This prospective study compared the effectiveness of a novel sanitizer containing electrolysed water, in which the active ingredient is stabilized hypochlorous acid (Aqualution™), with the effectiveness of the quaternary ammonium disinfectant in current use.
Evaluation of the antimicrobial effect of super-oxidized water (Sterilox®) and sodium hypochlorite against Enterococcus faecalis in a bovine root canal model Rossi-Fedele G1, Figueiredo JA, Steier L, Canullo L, Steier G, Roberts AP

CONCLUSIONS:

Sodium hypochlorite (NaOCl) is a well-known disinfectant due to its reduction properties and has been used in various medical applications, including disinfection, surface sanitizing, treating wounds, and treating periodontal infections [9]. However, due to its cytotoxicity and potential for producing chloramine as a byproduct, its use is limited in certain clinical settings [10].

RESULTS:

METHODOLOGY:

Root sections were prepared and inoculated with E. faecalis JH2-2. After 10 days of incubation the root canals were irrigated using one of three solutions (NaOCl, Optident Sterilox Electrolyte Solution® and Sterilox’s Aquatine Alpha Electrolyte®) and subsequently sampled by grinding dentin using drills. The debris was placed in BHI broth and dilutions were plated onto fresh agar plates to quantify growth.

RESULTS:

Sodium hypochlorite was the only irrigant to eliminate all bacteria. When the dilutions were made, although NaOCl was still statistically superior, Sterilox’s Aquatine Alpha Electrolyte® solution was superior to Optident Sterilox Electrolyte Solution®.

CONCLUSIONS:
Under the conditions of this study Sterilox’s Aquatine Alpha Electrolyte\textsuperscript{a} appeared to have significantly more antimicrobial action compared to the Optident Sterilox Electrolyte Solution\textsuperscript{a} alone, however NaOCl was the only solution able to consistently eradicate E. faecalis in the model.

Source: Abstract

1.1.8 Bactericidal effects of acidic electrolyzed water on the dental unit waterline. Kohno S1, Kawata T, Kaku M, Fuita T, Tsutsui K, Ohtani J, Tenjo K, Motokawa M, Tohma Y, Shigekawa M, Kamata H, Tanne K.

Many studies have been conducted in the United States regarding the microbial contamination of dental unit waterline, but not in Japan. Recently, acidic electrolyzed water has been used in the medical and dental fields. In this study, we investigated the bactericidal effects of the temporary inflow of acidic electrolyzed water on microbial contamination of the dental unit waterline. First, in order to observe the daily bacterial contamination of the dental unit waterline, water samples were collected at the end of handpieces and three-way syringes before the inflow of acidic electrolyzed water. They were cultured to detect viable bacteria. Later, the inflow of acidic electrolyzed water was conducted through the piping box of the dental unit. Before starting operation on next day, water samples were collected and cultured, as described above. The mean viable bacteria count was 910 (-/+) 190 CFU/ml at the end of handpieces, and 521 (-/+) 116 CFU/ml at the end of three-way syringes before the inflow of acidic electrolyzed water. However, bacteria were detected in only small numbers at the end of handpieces and three-way syringes on the next day. These results indicated that acidic electrolyzed water could be applied as an appropriate measure against bacterial contamination of the dental unit waterline.

Source: Abstract

1.1.9 An investigation of the efficacy of super-oxidised water for the disinfection of dental unit water lines. M V Martin\textsuperscript{I} & M A Gallagher

Aims To determine the efficacy of super-oxidised water (Optident/Sterilox) in the decontamination of dental unit water lines.

Methods Dental units (10) were first purged with concentrated super-oxidised water. After purging, a 5% (v/v) super-oxidised water was used as a maintenance dose. Samples for microbiology were taken after 0, 1, 2, 3, 4, 5, 6, 7 d, and each week for a further 13 weeks.

Results After purging, 5% (v/v) super-oxidised water was successful in reducing the microbial counts to zero, although in three of the units some bacteria were intermittently isolated in the first week of treatment.

Conclusions Super-oxidised water was successful in the removal of bacteria from dental unit water supplies. Complete removal required the treatment with a purge phase of concentrated disinfectant and a maintenance phase of at least two weeks.

Source: British Medical Journal

1.1.10 Ultrasonically nebulised electrolysed oxidising water: A promising new infection control programme for impressions, metals and gypsum casts used in dental hospitals Article in Journal of Hospital Infection 68(4):348-54 · April 2008 DOI: 10.1016/j.jhin.2008.01.02

Controlling the transmission of infectious diseases by impressions, metals and dental casts in dental hospitals remains a challenge. Current disinfection methods have various drawbacks. This study introduced and provided a preliminary evaluation of the feasibility of using ultrasonically nebulised, electrolysed oxidised water (UNOW) as a new infection control programme. UNOW was produced from freshly generated electrolysed oxidising water (EOW). Samples of impressions, titanium and gypsum were subjected to the following treatments: (1) immersion in 1% sodium hypochlorite for 10min; (2) immersion in EOW for 10min; (3) exposure to UNOW for 15, 30 and 45min; (4) no disinfection (control). Bactericidal efficacy was examined using Staphylococcus aureus and Bacillus subtilis var. niger spores as indicators. Dimensional accuracy, surface quality, and effect of corrosion were also evaluated for the different samples. Results showed that except for B. subtilis var. niger spores on gypsum casts, the bacterial reduction log(10) values after 30-45min treatment with UNOW were all above 4. The impression dimensional changes showed no difference between control and UNOW groups, but both were significantly lower than the EOW and sodium hypochlorite groups (P<0.05). The same was true for the surface quality of impressions and gypsum casts. No assessable corrosion was found on the titanium surface after a 45min treatment with UNOW. The findings indicated that use of UNOW is a feasible and promising approach for controlling the transmission of infectious diseases by impressions, gypsum casts and denture metals in dental facilities.

Source: PubMed


Hypochlorous acid (HOCl) is a potent oxidant, which is produced in vivo by activated phagocytes. This compound is an important antibacterial agent, but excessive or misplaced production has been implicated in a number of human diseases, including arthritis, and some cancers. Proteins are major targets for this oxidant, and such reaction results in side-chain modification, backbone fragmentation, and cross-linking. Despite a wealth of qualitative data for such reactions, little absolute kinetic data is available to rationalize the in vitro and in vivo data. In this study, absolute second-order rate constants for the reactions of HOCl with protein side chains, model compounds, and backbone amide (peptide) bonds have been determined at physiological pH values. The reactivity of HOCl with potential reactive sites in proteins is summarized by the series: Met (3.8 x 10(7) M(-1) s(-1)) > Cys (3.0 x 10(7) M(-1) s(-1)) > cystine (1.6 x 10(5) M(-1) s(-1)) approximately His (1.0 x 10(5) M(-1) s(-1)) > Trp (1.1 x 10(4) M(-1) s(-1)) > Tyr (5.0 x 10(3) M(-1) s(-1)) > Gly (44 M(-1) s(-1)) > backbone amides (10-100 M(-1) s(-1)) >> Gly(0.03 M(-1) s(-1)) approximately Asn (0.03 M(-1) s(-1)). The rate constants for reaction of HOCl with backbone amides (peptide bonds) vary by 4 orders of magnitude with uncharged peptide bonds reacting more readily with HOCl than those in a charged environment. These kinetic parameters have been used in computer modeling of the reactions of HOCl with human serum albumin, apolipoprotein-A1 and free amino acids in plasma at different molar excesses. These models are useful tools for
predicted, and reconciling, experimental data obtained in HOCl-induced oxidations and allow estimations to be made as to the flux of HOCl to which proteins are exposed in vivo.

1.1.13 **Hypochlorous Acid as a Potential Wound Care Agent. Part I. Stabilized Hypochlorous Acid: A Component of the Inorganic Armamentarium of Innate Immunity.** L. Wang, PhD,a M Bassiri, PhD,a R Najafi, PhD,a K Najafi, MD,b J Yang, BS,a B Khosrovi, PhD,a W Hwong, BS,a E Barati, BS,a B Bellese, PhD,a C Celeri, MS,a and MC Robson, MDc

Objective: Hypochlorous acid (HOCl), a major inorganic bactericidal compound of innate immunity, is effective against a broad range of microorganisms. Owing to its chemical nature, HOCl has never been used as a pharmacological drug for treating infection. In this article, we describe the chemical production, stabilization, and biological activity of a pharmacologically useful formulation of HOCl. Methods: Stabilized HOCl is in the form of a physiologically balanced solution in 0.9% saline at a pH range of 3.5 to 4.0. Chlorine species distribution in solution is a function of pH. In aqueous solution, HOCl is the predominant species at the pH range of 3 to 6. At pH values less than 3.5, the solution exists as a mixture of chlorine in aqueous phase, chlorine gas, trichloride (Cl3−), and HOCl. At pH greater than 5.5, sodium hypochlorite (NaOCl) starts to form and becomes the predominant species in the alkaline pH. To maintain HOCl solution in a stable form, maximize its antimicrobial activities, and minimize undesirable side products, the pH must be maintained at 3.5 to 5. Results: Using this stabilized form of HOCl, the potent antimicrobial activities of HOCl are demonstrated against a wide range of microorganisms. The in vitro cytotoxicity profile in L929 cells and the in vivo safety profile of HOCl in various animal models are described. Conclusion: On the basis of the antimicrobial activity and the lack of animal toxicity, it is predicted that stabilized HOCl has potential pharmaceutical applications in the control of soft tissue infection.


To evaluate the pretreatment effect of mild acidic HOCl solution on the microtensile bond strength (muTBS) of a two-step self-etch adhesive to dentin and the alteration of dentin surface pH.

METHODS: Thirty-nine flat ground coronal dentin specimens were divided into one control group and 12 experimental groups, which were treated with 6% NaOCl or 50, 100 and 200ppm HOCl (Comfosy) solutions for 5, 15 and 30s. After rinsing with running water for 30s, all the dentin surfaces were bonded with Clearfil SE Bond according to the manufacturer's instructions. After 24h water storage, the bonded specimens were sectioned and trimmed to an hourglass shape with a cross-sectional area of approximately 1.0mm(2) and then subjected to the muTBS test. Thirty-six mid-coronal dentin discs were used for surface pH measurement. Dentin surface pH with or without pretreatment was examined using a pH-imaging microscope (Schem-100). The muTBS data were analyzed by one-way ANOVA (Dunnett's T3) and the surface pH data were analyzed by non-parametric statistics (Mann-Whitney U-test).

RESULTS: Pretreatment with Comfosy at concentrations of 50, 100 and 200 ppm did not significantly affect muTBS regardless of the application time compared with the control group, however the 100 and 200ppm Comfosy groups showed significantly lower surface pH values. For the NaOCl pretreatment groups, a longer application time significantly decreased the muTBS and increased the surface pH values compared to the control group.

CONCLUSIONS: The 50ppm Comfosy pretreatments for 5, 15 and 30s did not affect the muTBS of the two-step self-etch adhesive to dentin and dentin surface pH.

1.1.15 **Acidic Electrolysed Water in the Disinfection of the Ocular Surface.** Shigeto Shimmura - Koki Matsumoto - Hiromoto Yaguchi - Kazuo Tsutob

Acid electrolysed water (AEW) is a colorless solution prepared by the electrolysis of sodium chloride solution, which has potent antimicrobial activity against a wide variety of bacteria, fungi and virus. In this study, the safety and efficacy of an isotonic AEW solution (IAEW) was investigated both in vitro and in vivo using denuded corneas of guinea pigs. Povidone iodine (0.01-1.0%) was used as control. Exposure of P. aeruginosa to IAEW for 5 sec caused total inhibition of bacterial growth in vitro. Comparable results were obtained with 1% povidone iodine, while more dilute solutions required longer exposure times for similar effects. Cytotoxicity of IAEW on corneal epithelial cells in vitro was significantly less compared to 1% povidone iodine (P<0.05), while minimal damage was observed in vivo by irrigation of the cornea with either IAEW or 1% povidone iodine. Treatment of P. aeruginosa with IAEW (15 sec) significantly inhibited the onset of corneal infection in guinea pigs. IAEW may offer an effective and safe method for disinfection of the ocular surface.


**Eur J Clin Microbiol Infect Dis April 2011**

Due to the limitations associated with the use of existing biocidal agents, there is a need to explore new methods of disinfection to help maintain effective bioburden control, especially within the healthcare environment. The transformation of low mineral salt solutions into an activated metastable state, by electrochemical unipolar action, produces a solution containing a variety of oxidants, including hypochlorous acid, free chlorine and free radicals, known to possess antimicrobial properties. Electrochemically activated solutions (ECAS) have been shown to have broad-spectrum antimicrobial activity, and have the potential to be widely adopted within the healthcare environment due to low-cost raw material requirements and ease of production (either remotely or in situ). Numerous studies have found ECAS to be highly efficacious, as both a novel environmental decontaminant and a topical treatment agent (with low accompanying toxicity), but they are still not in widespread use, particularly within the healthcare environment. This review provides an overview of the scientific evidence for the mode of action, antimicrobial spectrum and potential healthcare-related applications of ECAS, providing an insight into these novel yet seldom utilised biocides.

Source: [Abstract](#)

1.1.20 Super-Oxidized Solution (SOS) Therapy for Infected Diabetic Foot Ulcers

Paper from the compendium of Clinical Research and Practice September 2006: [Source](#)

1.1.21 Non-surgical Management of Chronic Wounds in Patients With Diabetes

Conclusion: Wounds fail to heal in a timely and orderly manner when regional blood flow is impaired, when infections are present and host immune mechanisms are damaged, and when invading flora are multidrug resistant. In the diabetic patient, the impact of all of these factors is commonly present and can have devastating effects, including limb loss and death. Key to healing wounds in diabetics is the resolution of metabolic issues, restoration of blood flow to ischemic and hypoxic tissues, and elimination of infection. None of these goals is simple, but all are necessary to reduce the staggering economic and social costs of wound care in diabetics. New wound treatment options, including superoxidized water and negative pressure devices, 60 antibacterial dressing materials, etc. have a positive effect on healing outcomes in general. New agents for ameliorating diabetes itself are increasingly available and will, hopefully, allow the patient to disrupt the downward spiral so common to the development, and retarded healing, of chronic wounds that occur in patients with diabetes. [Source](#)

1.1.22 A pilot study on microbial load reduction in peritonitis with a neutral pH – super-oxidized solution

Intra-abdominal sepsis is a clinical disorder commonly found in Mexican general hospitals. It has been published that from 2% to 14.76% of patients admitted to the emergency services of these institutions present abdominal sepsis (Rodea, 1999; Bracho, 2002). The problem is that mortalities rates are higher in certain regions of the country due to the lack of fully equipped intensive care units. But despite major advances in surgery, antibiotics as well as nutritional, ventilatory and hemodynamic supports in developed countries, mortality rates remain in the range of 10-20%. For these reasons, there has been an ongoing interest in reducing the mortality rates in peritonitis by improving source control. The latter includes an efficient eradication of infection, elimination of microbial contamination and restoration of the local environment (Holzheimer, 2001). Adjunct surgical measures, then, aim at the reduction of the bacterial load in the peritoneal cavity. For this purpose, planned relaparotomy, relaparotomy on demand, and intraoperative peritoneal lavage (IOPL) are all used as necessary. In severe peritonitis, for example, the use of multiple re-explorations and intraoperative lavage with large amounts of saline solution has been recommended to decrease the risk of postoperative infection. Yet, the benefit of adding antimicrobials or antiseptics to the lavage fluid remains controversial. Tauridoline, metronidazol and iodine povidone are some of the products so far tested. The bactericidal and anti-endotoxin product taurodoline, for example, has been shown to reduce the complication rates and length of hospital stay in patients with local peritonitis undergoing laparoscopy treatment (Gortz, 1997). Adjunct metronidazol lavage has also been suggested as an efficient therapy for the treatment of intraperitoneal abscesses (Saha, 1996). However, no data has been further published on the efficacy and toxicity of these products. In addition, the use of iodine povidone for intraperitoneal lavage in colorectal surgery has been shown to lead to sclerosing encapsulating peritonitis (SEP) (Keating, 1997). In an attempt to reduce chemical-related toxicity to the peritoneum, Inoue et al. (1997), performed lavages with an electrolyzed strong acid aqueous solution to Barrera A et al. Use of SOS in Peritonitis Final Report Oculus Innovative Sciences 062306 Department of Medical Affairs 3 treat 7 patients with peritonitis and intraperitoneal abscesses. This was an antimicrobial solution that contained reactive oxygen species, high chlorine content (>600 ppm) and, therefore, a high oxidation-reduction potential (OPR). As expected, the four positive cultures found at entry became negative between days 3-7 after irrigation with the solution twice a day. Thus, the concept of using a super-oxidized solution (SOS) for source control in peritonitis resulted attractive. [Source](#)

1.1.23 Neutral Super-Oxidised Solutions Effective in killing P. aeruginosa biofilms

Bacteria growing in biofilms can become up to 1000-fold more resistant to antibiotics and biocides as compared to their planktonic counterparts. As a result of this increased resistance, biofilms and biofilm-related infections cannot be effectively treated with conventional antibiotic therapy. The goal of this study was to determine the efficacy of three neutral pH, super-oxidised solutions (nSOS,
OIS-80, OIS-125, OIS-200, Microcyn Technology) varying in oxychlorine concentration (80, 125 and 200 ppm) against P. aeruginosa grown planktonically and as biofilms. Exposure for 20 s of exponential phase cells to any of the three solutions was sufficient to reduce viability by more than five logs. However, only exposure for 10 min to OIS-125 and OIS-200 for 10 min was sufficient to eradicate stationary phase P. aeruginosa cells. The efficacy of nSOs on P. aeruginosa biofilms, grown to maturity in continuous flow tube reactors, was determined upon treatment up to 60 min. Viability pre- and post-treatment was determined by CFU counts. The effect of these solutions on P. aeruginosa biofilms and biofilm architecture was further visualised by confocal scanning laser microscopy and quantitatively analysed by COMSTAT. Under these experimental conditions, only OIS-125 and OIS-200 achieved a 43-log reduction and biofilm disaggregation within 30 min of exposure. Because OIS-125 and OIS-200 enhance the disaggregation of biofilms, their use in the treatment of surface-related biofilm infections deserves further investigation. Source

1.1.24 Comparative Efficacy and Tolerability of Microcyn Super-Oxidize Solution (Oxum) against Povidone Iodine Topical Application in the Post-caesarean Section Wound Management

Conclusion: Oxum (Microcyn Superoxidized solution) is safe and effective in post-caesarean wound care management and gives better efficacy and faster response as compared to the traditional Povidone-iodine topical application in post caesarean section wound care management Source


Eur J Clin Microbiol Infect Dis April 2011

Due to the limitations associated with the use of existing biocidal agents, there is a need to explore new methods of disinfection to help maintain effective bioburden control, especially within the healthcare environment. The transformation of low mineral salt solutions into an activated metastable state, by electrochemical unipolar action, produces a solution containing a variety of oxidants, including hypochlorous acid, free chlorine and free radicals, known to possess antimicrobial properties. Electrochemically activated solutions (ECAS) have been shown to have broad-spectrum antimicrobial activity, and have the potential to be widely adopted within the healthcare environment due to low-cost raw material requirements and ease of production (either remotely or in situ). Numerous studies have found ECAS to be highly efficacious, as both a novel environmental decontaminant and a topical treatment agent (with low accompanying toxicity), but they are still not in widespread use, particularly in the healthcare environment. This review provides an overview of the scientific evidence for the mode of action, antimicrobial spectrum and potential healthcare-related applications of ECAS, providing an insight into these novel yet seldom utilised biocides. Source: Abstract

1.1.26 Diabetic Micro-Vascular Complication Today

Conclusion: Superoxidized water is effective in reducing bacterial load,5 enhancing local blood supply, accelerating development of neovascularity and providing a wound environment that is hostile to opportunistic organisms. Although superoxidized water is an extremely effective agent in wound management, it will not replace administration of good wound care practices. A multidisciplinary approach to wound care will include assertion of glycemic control, appropriate systemic antibiotic, nutritional amendment and attention to the overall social, medical and economic needs of the patient. Source

1.1.27 A Novel Super-Oxidized water with neutral pH and Disinfectant activity

Conclusion: ... the concept of SOW to create a highlevel disinfectant (or sterilant) maintains its appeal because the basic materials, saline solution and electricity, are inexpensive. In addition, the end product is non-flammable and there are no special requirements for handling or disposal. Therefore, SOWs such as Microcyn are environmentally safe agents and the costs derived from the disposal of toxic chemicals in hospitals could diminish by simply discarding them locally. Altogether, these data suggest that Microcyn could play a significant role as an effective and safe disinfectant in hospital practice. Additional studies are now being conducted to determine if this solution may be used as an antiseptic and highlevel disinfectant. Source

1.1.28 Treatment of Diabetic Foot Ulcer: An Overview of Strategies for Clinical Approach

Mention on page 14 of published paper of prospects for ionised water or super oxidised water (highlighted). Source

1.1.29 Super-Oxidized Solution inhibits IgE-antigen-induced degranulation and cytokine release in mast cells

Activation of the high affinity IgE receptor (Fc εRI) through IgE-antigen complexes induces mast cell degranulation, synthesis 11 of lipid mediators and cytokine production. These effects are involved in Type I hypersensitivity reactions and controlling them has 12 been the main objective of many anti-allergic therapies. In addition, we report that pretreatment of murine bone marrow derived mast cells 13 (BMMC) with super-oxidized solution (SOS) inhibits Fc εRI dependent- β hexosaminidase and cytokine release. This effect is 14 exerted without altering total protein tyrosine phosphorylation, MAPK activation, cytokine mRNA accumulation or calcium mobilization after Fc εRI triggering. Our data suggest that this neutral pH-SOS acts like a mast cell-membrane stabilizer inhibiting 15 the cell machinery for granule secretion without altering the signal transduction pathways induced by IgE-antigen receptor 17 crosslinking. Source

1.1.30 An evaluation of one test product for its antimicrobial properties when challenged with various micro-organism strains using an in-vitro time-kill method

Source

1.1.31 Panel Intelligence Report - Diabetic Foot Infection Treatment

Source


1.1.34 Bongiovanni, CM, Superoxidized Water Improves Wound Care Outcomes in Diabetic Patients; Diabetic Microvascular Complications Today, 2006, May-June: 11-14


1.1.51 Stuttgart Congress 2005 (various papers)

Digest of papers


Conclusion Electrochemical water disinfection has many advantages compared with conventional disinfection technologies. It has proven its reliability in several practical applications, mainly for the disinfection of drinking water, swimming pool water and industrial cooling water. Electrochemical water disinfection has also been used or tested for the reduction of bacterial contamination in dental water supplies (32), and for the disinfection of contact lenses (33) and ion exchange resins (34) etc. However, only a few electrochemical water disinfection products are currently available on the market. This is due to the relative unfamiliarity of the technology, and to fierce market competition with other technologies. Eventually, the cost and performance advantages of electrochemical technology should lead to its wider use.

Source: Abstract


Russian text

2 Veterinary


Standards of the German Association of Veterinary Medicine (DVG) for the evaluation of chemical disinfectants were used to assess the anti-microbial efficacy of electrolyzed oxidizing water (EOW). Enterococcus faecium, Mycobacterium avium subspecies avium, Proteus mirabilis, Pseudomonas aeruginosa, Staphylococcus aureus and Candida albicans were exposed to anode EOW (pH, 3.0+/-0.1; oxidation-reduction potential (ORP), +1100+/-50 mV; free chlorine, 400+/-20 mg/l CI2) and combined EOW (7:3 anode:cathode, v/v; pH, 8.3+/-0.1; ORP, 930-950 mV; free chlorine, 271+/-20 mg/l CI2). In water of standardized hardness (WSH), all bacterial strains were completely inactivated by a 30 min exposure to maximum 10.0% anode EOW (approximately 40.0 mg/l CI2) or 50.0% combined EOW (approximately 135.5 mg/l CI2). The sensitivity ranking order for anode EOW to the bacterial test strains was P. mirabilis>S. aureus>M. avium ss. avium>E. faecium>P. aeruginosa. P. mirabilis and S. aureus decreased to undetectable levels after 5 min of exposure to 7.5% anode EOW (approximately 30.0 mg/l CI2). Candida albicans was completely inactivated by a 5-min exposure to 5.0% anode EOW. Both, anode and combined EOW exhibited no anti-microbial activities in standardized nutrient broth or after addition of 20.0% bovine serum to the WSH. Further research is necessary to evaluate the efficacy of EOW as a disinfectant under operating conditions in animal production facilities.

Source: Abstract

3 Food Industry General


Electrolyzed water (EW) is gaining popularity as a sanitizer in the food industries of many countries. By electrolysis, a dilute sodium chloride solution dissociates into acidic electrolyzed water (AEW), which has a pH of 2 to 3, an oxidation-reduction potential of >1,100 mV, and an active chlorine content of 10 to 90 ppm, and basic electrolyzed water (BEW), which has a pH of 10 to 13 and an oxidation-reduction potential of -800 to -900 mV. Vegetative cells of various bacteria in suspension were generally reduced by > 6.0 log CFU/ml when AEW was used. However, AEW is a less effective bactericide on utensils, surfaces, and food products because of factors such as surface type and the presence of organic matter. Reductions of bacteria on surfaces and utensils or vegetables and fruits mainly ranged from about 2.0 to 6.0 or 1.0 to 3.5 orders of magnitude, respectively. Higher reductions were obtained for tomatoes. For chicken carcasses, pork, and fish, reductions ranged from about 0.8 to 3.0, 1.0 to 1.8, and 0.4 to 2.8 orders of magnitude, respectively. Considerable reductions were achieved with AEW on eggs. On some food commodities, treatment with BEW followed by AEW produced higher reductions than did treatment with AEW only. EW technology deserves consideration when discussing industrial sanitization of equipment and decontamination of food products. Nevertheless, decontamination treatments for food products always should be considered part of an integral food safety system. Such treatments cannot replace strict adherence to good manufacturing and hygiene practices.

Source: Abstract


Source:


Source:

3.1.4 Cleaning in place with onsite-generated electrolyzed oxidizing water for water-saving disinfection in breweries Lu Chen · Rong Chen · Hua Yin · [..] · Hong Lin

The use of acid electrolyzed water (AcEW) is a relatively new sanitizing technique for brewery equipment. Experiments showed that a 30% AcEW (a free chlorine concentration of above 17 mg/L) was a sufficient and effective alternative to conventional sanitizers such as peracetic acid (2%). On the basis of the results of industrial-scale clean-in-place tests, an effective AcEW-based clean-in-place procedure, which requires only 10 min of cleaning and does not require final water rinsing after sanitization, was established for the bright beer tank.

Copyright © 2013 The Institute of Brewing & Distilling


Source:


The efficacy of Electrolysed Oxidising Water (EOW) for inactivating spoilage microorganisms in process water and on minimally processed vegetables was investigated. The direct effect of EOW on three important spoilage bacteria namely: Pseudomonas fluorescens, Pantoaea
agglomerans or Rahnella aquatilis was determined by inoculating tap water or "artificial process water" with approximately 8 log CFU/ml pure culture and electrolyzing the resultant solutions. The three bacteria were each reduced to undetectable levels at low (0.5 A) and relatively higher levels (1.0 A) of current in tap water and "artificial process water", respectively. The residual effect of EOW on P. fluorescens, P. agglomerans or R. aquatilis was determined by incubating at room temperature 1 ml (approximately 9 log CFU/ml) pure culture suspensions in 9 ml of EOW-T (EOW produced from tap water), EOW-A (EOW produced from "artificial process water" supplemented with approximately 60.7 mg Cl(⁻)/l and 39.3 mg Na(⁺)/l) or deionised water (control) for 0, 15, 45 or 90 min. The bactericidal activity of both EOW-T and EOW-A increased with the concentration of free oxidants and incubation period and the three bacteria were completely reduced at free oxidants-incubation period combinations of 3.88 mg/l-45 min and 5.1 mg/l-90 min in EOW-T and EOW-A, respectively. Two types of industrial vegetable process water; salad-mix and soup process water, which had each a total psychrotrophic count of approximately 8 log CFU/ml were then electrolysed. Without any NaCl addition, only 1.2 and 2.1 log reductions of the psychrotrophs in soup and salad-mix process water was attained respectively. Supplementation of the process water with approximately 60.7 mg Cl⁻/l and 39.3 mg Na⁺/l afterwards resulted in complete reduction of the psychrotrophic count in both process waters, but soup process water required relatively higher levels of current compared to salad-mix water. Finally, fresh-cut lettuce was washed in EOW-T containing 3.62 mg free oxidants/l, EOW-IP (EOW produced from industrial process water) containing 2.8 mg free oxidants/l or tap water (control) for 1 or 5 min. Washing the vegetables for 1 min in EOW-T resulted in 1.9, 1.2, and 1.3 log reductions of psychrotrophs, lactic acid bacteria and Enterobacteriaceae, respectively, which increased to 3.3, 2.6, and 1.9 log reductions after washing for 5 min instead. EOW-IP tested in this work had no bactericidal effect on the microflora of fresh-cut lettuce. Electrolysis could therefore be used to decontaminate process water for vegetable pre-washing and to sanitise tap water for final rinsing of vegetables, respectively.

Source: Abstract

3.2 Ready to Eat Meals


Source:

3.3 Surfaces and Cutting Boards

3.3.1 Efficacy of Low Concentration Neutralised Electrolysed Water and Ultrasound Combination for Inactivating Escherichia coli ATCC 25922, Pichia pastoris GS115 and Aureobasidium pullulans 2012 on Stainless Steel CouponsLin Zhao · Ying Zhang · Hongshun Yang

The sanitising effect of low concentration neutralised electrolysed water (LCNEW, pH: 7.0, free available chlorine (FAC): 4 mg/L) combined with ultrasound (37 kHz, 80 W) on food contact surface was evaluated. Stainless steel coupon was chosen as attachment surface for Escherichia coli ATCC 25922, Pichia pastoris GS115 and Aureobasidium pullulans 2012, representing bacteria, yeast and mold, respectively. The results showed that although LCNEW itself could effectively reduce survival population of E. coli ATCC 25922, P. pastoris GS115 and low concentration A. pullulans 2012 in planktonic status, LCNEW combined with ultrasound showed more sanitising efficacy for air-dried cells on coupons, with swift drops: 2.2 and 3.1 log CFU/coupon reductions within 0.2 min for E. coli ATCC 25922 and P. pastoris GS115, respectively and 1.0 log CFU/coupon reductions within 0.1 min for A. pullulans 2012. Air-dried cells after treatment were studied by atomic force microscopy (AFM)/optical microscopy (OM) and protein leakage analyses further. All three strains showed visible cell damage after LCNEW and LCNEW combined with ultrasound treatment and 1.41 and 1.73 μg/mL of protein leakage were observed for E. coli ATCC 25922 and P. pastoris GS115, respectively after 3 min combination treatment, while 6.22 μg/mL of protein leakage for A. pullulans 2012 after 2 min combination treatment. For biofilms, LCNEW combined with ultrasound also significantly reduced the survival cells both on coupons and in suspension for all three strains. The results suggest that LCNEW combined with ultrasound is a promising approach to sanitise food equipment.

Source:


Source:


Source:


Source:


Source:

AIM: To ascertain the efficacy of neutral electrolysed water (NEW) in reducing Escherichia coli, Pseudomonas aeruginosa, Staphylococcus aureus and Listeria monocytogenes on glass and stainless steel surfaces. Its effectiveness for that purpose is compared with that of a sodium hypochlorite (NaClO) solution with similar pH, oxidation-reduction potential (ORP) and active chlorine content.

METHODS AND RESULTS: First, the bactericidal activity of NEW was evaluated over pure cultures (8.5 log CFU ml-1) of the abovementioned strains: all of them were reduced by more than 7 log CFU ml-1 within 5 min of exposure either to NEW (63 mg l-1 active chlorine) or to NaClO solution (62 mg l-1 active chlorine). Then, stainless steel and glass surfaces were inoculated with the same strains and rinsed for 1 min in either NEW, NaClO solution or deionized water (control). In the first two cases, the populations of all the strains decreased by more than 6 log CFU 50 cm-2. No significant difference (P≤0.05) was found between the final populations of each strain with regard to the treatment solutions (NEW or NaClO solution) or to the type of surface.

CONCLUSIONS: NEW was revealed to be as effective as NaClO at significantly reducing the presence of pathogenic and spoilage bacteria (in this study, E. coli, L. monocytogenes, P. aeruginosa and S. aureus) on stainless steel and glass surfaces.

SIGNIFICANCE AND IMPACT OF THE STUDY: NEW has the advantage of being safer than NaClO and easier to handle. Hence, it represents an advantageous alternative for the disinfection of surfaces in the food industry.

Source: Abstract

3.3.7 Effectiveness of electrolyzed water as a sanitizer for treating different surfaces. Park, H., Y.-C. Hung, and C. Kim. 2002. *J. Food Prot.* 65:1276–1280

The effectiveness of electrolyzed (EO) water at killing Enterobacter aerogenes and Staphylococcus aureus in pure culture was evaluated. One milliliter (approximately 10(9) CFU/ml) of each bacterium was subjected to 9 ml of EO water or control water (EO water containing 10% neutralizing buffer) at room temperature for 30 s. Inactivation (reduction of > 9 log10 CFU/ml) of both pathogens occurred within 30 s after exposure to EO water containing approximately 25 or 50 mg of residual chlorine per liter. The effectiveness of EO water in reducing E. aerogenes and S. aureus on different surfaces (glass, stainless steel, glazed ceramic tile, unglazed ceramic tile, and vitreous china) was also evaluated. After immersion of the tested surfaces in EO water for 5 min without agitation, populations of E. aerogenes and S. aureus were reduced by 2.2 to 2.4 log10 CFU/cm² and by 1.7 to 1.9 log10 CFU/cm², respectively, whereas washing with control water resulted in a reduction of only 0.1 to 0.3 log10 CFU/cm². The washing of tested surfaces in EO water with agitation (50 rpm) reduced populations of viable cells on the tested surfaces to < 1 CFU/cm². For the control water treatment with agitation, the surviving numbers of both strains on the tested surfaces were approximately 3 log10 CFU/cm². No viable cells of either strain were observed in the EO water after treatment, regardless of agitation. However, large populations of both pathogens were recovered from control wash solution after treatment.

Source: Abstract

4 Biofilms


Biofilms are potential sources of contamination in food in processing plants, because they frequently survive sanitizer treatments during cleaning. The objective of this research was to investigate the combined use of alkaline and acidic electrolyzed (EO) water in the inactivation of Listeria monocytogenes biofilms on stainless steel surfaces. Biofilms were grown on rectangular stainless steel (type 304, no. 4 finish) coupons (2 by 5 cm) in a 1:10 dilution of tryptic soy broth that contained a five-strain mixture of L. monocytogenes for 48 h at 25 degrees C. The coupons with biofilms were then treated with acidic EO water or alkaline EO water or with alkaline EO water followed by acidic EO water produced at 14 and 20 A for 30, 60, and 120 s. Alkaline EO water alone did not produce significant reductions in L. monocytogenes biofilms when compared with the control. Treatment with acidic EO water only for 30 to 120 s, on the other hand, reduced the viable bacterial populations in the biofilms by 4.3 to 5.2 log CFU per coupon, whereas the combined treatment of alkaline EO water followed by acidic EO water produced an additional 0.3– to 1.2-log CFU per coupon reduction. The population of L. monocytogenes reduced by treatments with acidic EO water increased significantly with increasing time of exposure. However, no significant differences occurred between treatments with EO water produced at 14 and 20 A. Results suggest that alkaline and acidic EO water can be used together to achieve a better inactivation of biofilms than when applied individually.

Source: Abstract


Source:


Source:


Source:


Source:

Source:


Source:


Source:


Source:

5 Plants

5.1 General


Source:


Source:


Source:

5.2 Fruit

5.2.1 A review of microbiological safety of fruits and vegetables and the introduction of electrolyzed water as an alternative to sodium hypochlorite solution Abdulsudi Issa-Zacharia, Yoshinori Kamitani, Happiness S. Muhimbula and Bernadette K. Ndbikunze African Journal of Food Science Vol. 4(13), pp. 778 - 789 December 2010

Over the past few years, food safety has become and continues to be the number one public concern. Considerable progress to strengthen food safety systems has been achieved in many countries, highlighting the opportunities to reduce and prevent food-borne disease. However, unacceptable rates of food-borne illness still remain and new hazards continue to enter the food supply chain. Contaminations in food and agricultural products may occur in every stage of the food supply chain, from the field to the table, that is production, harvesting, processing, storage and distribution, calling for proper decontamination and insuring food safety at each of these stages using an effective antimicrobial agent. Several commercial products are available for this purpose, however, most of available products are seriously hindered by a number of work and environmental safety limitations calling for the development of a new product which is both safe for environment and workers. In this accord, the use of acidic electrolyzed water (AEW), a new concept developed in Japan, which is now gaining popularity in other countries has been introduced. The principle behind its sterilizing effect is still explored, but it has shown to have strong and significant bactericidal and virucidal and moderate fungicidal properties. Some studies have been carried out in Japan, China, Korea, Canada, Europe and the USA on its pre- and post-harvest application in the field of food processing. This review provides an overview of microbiological safety of food and agricultural produces, points out the burdens of food borne diseases; highlights the drawbacks of currently employed sanitizers and introduces electrolyzed water as a novel non-thermal food sanitizer with potential of application in agriculture and food industry

Source: pdf

5.3 Strawberry


Survival of Escherichia coli O157:H7 was studied on strawberry, a fruit that is not usually washed during production, harvest, or postharvest handling. Two strains of the bacteria were tested separately on the fruit surface or injected into the fruit. Both strains of E. coli O157:H7 survived externally and internally at 23 degrees C for 24 h and at 10, 5, and -20 degrees C for 3 days. The largest reduction in bacterial population occurred at -20 degrees C and on the fruit surface during refrigeration. In all experiments, the bacteria inside the fruit either survived as well as or better than bacteria on the surface, and ATCC 43895 frequently exhibited greater survival than did ATCC 35150. Two strains of E. coli also survived at 23 degrees C on the surface and particularly inside strawberry fruit. Chemical agents in aqueous solution comprising NaOCl (100 and 200 ppm), Tween 80 (100 and 200 ppm), acetic acid (2 and 5%), Na3PO4 (2 and 5%), and H2O2 (1 and 3%) were studied for their effects on reduction of surface-inoculated (10(8) CFU/ml) E. coli O157:H7 populations on strawberry fruit. Dipping the inoculated fruit in water alone reduced the pathogen population about 0.8 log unit. None of the compounds with the exception of H2O2 exhibited more than a 2-log CFU/g reduction of the bacteria on the fruit surface. Three percent H2O2, the most effective chemical treatment, reduced the bacterial population on strawberries by about 2.2 log CFU/g.
5.4 Peach


Source: **Abstract**

5.5 Pear


Source: **Abstract**

5.6 Apples


Spores of *Penicillium expansum*, the primary organism responsible for the occurrence of patulin in apple juice, were exposed to electrolyzed oxidizing (EO) water in an aqueous suspension and on wounded apples. Full-strength and 50% EO water decreased viable spore populations by greater than 4 and 2 log units, respectively. Although EO water did not prevent lesion formation on fruit previously inoculated with *P. expansum*, cross-contamination of wounded apples from decayed fruit or by direct addition of spores to a simulated dump tank was substantially reduced. EO water, therefore, has potential as an alternative to chlorine disinfectants for controlling infection of apples by *P. expansum* during handling and processing operations.

Source: **Abstract**

5.7 Figs

5.7.1 Article: EFFICACY OF NEUTRALISED ELECTROLYSED WATER AND MILD HEAT AGAINST FOODBORNE PATHOGENS ISOLATED FROM FICUS CARICA Cicdem ileri yamaner · Muuvvzt Ayvaz · Ramazan Konak · [...] Anatoli Dimoglo

Problems with microorganism toxins in dried fig exports are becoming very important. Chlorine-based sanitizers are effective way of controlling microorganisms, but on the other hand their reaction with natural organic and inorganic matter may potentially form carcinogenic products. Therefore, different sanitizers for the disinfection of food and food contact surfaces are required as an alternative to chlorine-based sanitizers. Some earlier studies revealed that neutralised electrolysed water (NEW) may be a potential substitute for cleaning and sanitizing agents in packaged products. In order to make a contribution to solve toxins problems, the antibacterial and antifungal effect of neutralised electrolysed water (NEW) on the foodborne pathogens were evaluated in this study. Spores of Aspergillus flavus and *Penicillium expansum* were isolated from the surface of fig fruits. *Escherichia coli* and *Bacillus cereus* known to occur on the surface of figs were also evaluated. Vegetative cells and spores of bacterium and fungi were exposed to five different concentrations of NEW (100, 75, 25, 5 and 1%) at three different temperatures (22, 50 and 70°C) for 1, 3 and 5 min. According to the results, at 22°C, 1% neutralised electrolysed water exposure for 1 min effectively decreased the number of vegetative cells of *E. coli* and *B. cereus* by approximately 8.5 log cfu/ml and 6.3 log cfu/ml, respectively. At 50°C, 5% neutralised electrolysed water exposure for 1 min significantly reduced the A. flavus and *P. expansum* spore numbers by 5.54 log cfu/ml and 7 log cfu/ml, respectively. With the effect of mild temperature (22-50°C), low chlorine neutralised electrolysed water (9.22 mg/L-33.85 mg/L available chlorine concentrations) showed a strong antibacterial and antifungal activity against foodborne pathogens. As a conclusion, neutralised electrolysed water can be used widely as a sanitizer in fig enterprises, instead of high cost chlorine based disinfectants.

5.8 Cut Vegetables


The effect of electrolyzed water on total bacterial count was evaluated on several fresh-cut vegetables. When fresh-cut carrots, bell peppers, spinach, Japanese radish, and potatoes were treated with electrolyzed water (pH 6.8, 20 ppm available chlorine) by dipping, rinsing, or dipping/blowing, microbes on all cuts were reduced by 0.6 to 2.6 logs CFU/g. Rinsing or dipping/blowing were more effective than dipping. Electrolyzed water containing 50 ppm available chlorine had a stronger bactericidal effect than that containing 15 or 30 ppm chlorine for fresh-cut carrots, spinach, or cucumber. Electrolyzed water did not affect tissue pH, surface color, or general appearance of fresh-cut vegetables.

Source: **Abstract** pdf


The main factor contributing to the disinfecting potential of acidic electrolyzed water (AcEW) is deduced to be the oxidizing power of available chlorine. In this study, we compared the reliability of two different methods for measuring the available chlorine concentration (ACC). Several AcEW solutions with different levels of ACC to which various reducing agents (ascorbic acid, ammonium iron(II) sulfate, and iron(II) chloride) had been added were prepared. These ACC levels were quantified by iodometry and the DPD (N,N-diethyl-p-phenylenediamine) method. In the case of AcEW with iron(II) ions, iodometry did not show the correct ACC. On the other hand, the DPD method correctly quantified ACC even in the case of AcEW with iron(II) ions. Thus, the DPD method is an appropriate method for measuring ACC in AcEW. Moreover, we investigated the effect of the available chlorine concentration (ACC) in AcEW on its disinfecting...
potential. First, we examined the disinfectant effects of AcEW on shredded vegetables. We found that there was no difference in the disinfectant effects between AcEW with high ACC (40ppm) and low ACC (0.4ppm). The similar effect was detected in AcEW with 0ppm of ACC, a solution that seemed to be the same as hydrochloric acid. Moreover, tap water with pH adjusted to 2.4 showed the same disinfectant effect as that of AcEW. These results indicated that AcEW is a solution in which available chlorine is activated in a low pH condition. Next, we examined the disinfectant effects of AcEW on a suspension obtained from shredded vegetables in vitro. The disinfecting potential became weaker, but did not completely disappear, when ACC was reduced to 0ppm.

Source: Abstract


Effects of storage temperature (1, 5, and 10 degrees C) on growth of microbial populations (total aerobic bacteria, coliform bacteria, Bacillus cereus, and psychrotrophic bacteria) on acidic electrolyzed water (AcEW)-treated fresh-cut lettuce and cabbage were determined. A modified Gompertz function was used to describe the kinetics of microbial growth. Growth data were analyzed using regression analysis to generate "best-fit" modified Gompertz equations, which were subsequently used to calculate lag time, exponential growth rate, and generation time. The data indicated that the growth kinetics of each bacterium were dependent on storage temperature, except at 1 degrees C storage. At 1 degrees C storage, no increases were observed in bacterial populations. Treatment of vegetables with AcEW produced a decrease in initial microbial populations. However, subsequent growth rates were higher than on untreated vegetables. The recovery time required by the reduced microbial population to reach the initial (treated with tap water [TW]) population was also determined in this study, with the recovery time of the microbial population at 10 degrees C being <3 days. The benefits of reducing the initial microbial populations on fresh-cut vegetables were greatly affected by storage temperature. Results from this study could be used to predict microbial quality of fresh-cut lettuce and cabbage throughout their distribution.

Source: Abstract

5.9 Tomatoes


A study was conducted to evaluate the efficacy of electrolyzed acidic water, 200-ppm chlorine water, and sterile distilled water in killing Escherichia coli O157:H7, Salmonella, and Listeria monocytogenes on the surfaces of spot-inoculated tomatoes. Inoculated tomatoes were sprayed with electrolyzed acidic water, 200-ppm chlorine water, and sterile distilled water (control) and rubbed by hand for 40 s. Populations of E. coli O157:H7, Salmonella, and L. monocytogenes in the rinse water and in the peptone wash solution were determined. Treatment with 200-ppm chlorine water and electrolyzed acidic water resulted in 4.87- and 7.85-log10 reductions, respectively, in Escherichia coli O157:H7 counts and 4.69- and 7.46-log10 reductions, respectively, in Salmonella counts. Treatment with 200-ppm chlorine water and electrolyzed acidic water reduced the number of L. monocytogenes by 4.76 and 7.54 log10 CFU per tomato, respectively. This study's findings suggest that electrolyzed acidic water could be useful in controlling pathogenic microorganisms on fresh produce.

Source: Abstract


AIMS: To determine the efficacy of neutral electrolyzed water (NEW) in killing Escherichia coli O157:H7, Salmonella enteritidis and Listeria monocytogenes, as well as nonpathogenic E. coli, on the surface of tomatoes, and to evaluate the effect of rinsing with NEW on the organoleptical characteristics of the tomatoes.

METHODS AND RESULTS: The bactericidal activity of NEW, containing 444 or 89 mg l(-1) of active chlorine, was evaluated over pure cultures (8.5 log CFU ml(-1)) of the above-mentioned strains. All of them were reduced by more than 6 log CFU ml(-1) within 5 min of exposure to NEW. Fresh tomatoes were surface-inoculated with the same strains, and rinsed in NEW (89 mg l(-1) of active chlorine) or in deionized sterile water (control), for 30 or 60 s. In the NEW treatments, independent of the strain and of the treatment time, an initial surface population of about 5 log CFU sq.cm(-1) was reduced to <1 log CFU sq.cm(-1), and no cells were detected in the washing solution by plating procedure. A sensory evaluation was conducted to ascertain possible alterations in organoleptic qualities, yielding no significant differences with regard to untreated tomatoes.

SIGNIFICANCE AND IMPACT OF THE STUDY: Rinsing in NEW reveals as an effective method to control the presence of E. coli O157:H7, S. enteritidis and L. monocytogenes on the surface of fresh tomatoes, without affecting their organoleptical characteristics. This indicates its potential application for the decontamination of fresh produce surfaces.

Source: Abstract


This study compared the effect of different physical and chemical treatments of strawberries and tomatoes to determine their ability to recover seeded viral and bacterial pathogens from produce surfaces. Solutions of salts, amino acids, complex media, and detergents were compared as eluents. Phosphate-buffered saline (PBS) containing 0.1% Tween 80 eluted the highest number of seeded microorganisms. Elution with this defined solution was then compared under different conditions of physical agitation. Rotary shaking for 20 min at 36 degrees C eluted higher numbers of viruses and bacteria than did low- or high-speed stomaching. Commercially available and laboratory-prepared bacteriological differential media were compared for their ability to recover and distinguish eluted Salmonella Montevideo and
Escherichia coli O157:H7 strains from seeded produce. The recovery of seeded bacterial pathogens was low when differential media containing selective ingredients were used (MacConkey sorbitol agar, XLD agar, MacConkey agar). Highest recoveries were obtained on a medium consisting of tryptic soy agar supplemented with sodium thiosulfate and ferric ammonium citrate compared with selective media that inhibited up to 50% of the growth of the eluted microorganisms.

Source: Abstract

5.9.4 Fate of foodborne pathogens on green onions and tomatoes by electrolysed water E-J Park · E Alexander · G.A. Taylor · […] · D-H Kang To investigate the efficacy of electrolysed water (EW) in killing Escherichia coli O157:H7, Salmonella typhimurium and Listeria monocytogenes on the surfaces of spot-inoculated green onions and tomatoes. Green onions and tomatoes were inoculated with a cocktail of three strains each of E. coli O157:H7, Salm. typhimurium and L. monocytogenes and treated with acidic electrolysed water (AC-EW), alkaline electrolysed water (AK-EW), alkaline electrolysed water followed by acidic electrolysed water (AK-EW + AC-EW), deionized water followed by acidic electrolysed water (DW + AC-EW) and deionized water (control, DW) for 15 s, 30 s, 1 min, 3 min and 5 min at room temperature (22 ± 2 degrees C). The relative efficacy of reduction was AC-EW > DW + AC-EW approximately AK-EW + AC-EW > AK-EW > DW. Acidic EW treatment was able to significantly reduce populations of the three tested pathogens from the surfaces of green onions and tomatoes with increasing exposure time. Rinsing in acidic EW reveals an effective method to control the presence of E. coli O157:H7, Salm. typhimurium and L. monocytogenes on the surfaces of fresh green onions and tomatoes, without affecting their organoleptic characteristics. This indicates its potential application for the decontamination of fresh produce surfaces.

Source: Abstract

5.10 Flowers


Acidic electrolyzed oxidizing (EO) 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 EO water will not cause excessive phytotoxic symptoms on a wide variety of species. In one experiment, two applications of EO water did not damage 15 species of bedding plants. In a second experiment, EO water applied as a foliar spray three times per week for 4–7 weeks did not produce any visible phytotoxicity on seven of the 12 species tested. Small, white spots were observed on flowers of geranium (Pelargonium x hortorum), impatiens (Impatiens walleriana), and vinca (Catharanthus roseus). Slight necrosis was observed on some leaf edges of petunia (Petunia x hybridra), and snapdragon (Antirrhinum majus). EO water generated from magnesium chloride produced more phytotoxicity than EO water generated by potassium chloride or sodium chloride. Phytotoxicity ratings of greater than 3 (0–10 scale) were not observed on any of the species tested. EO water caused 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.

Source: Abstract

5.11 Cucumber


An examination was made of the efficacy of acidic electrolyzed water (AcEW, 30 ppm free available chlorine), ozonated water (5 ppm ozone), and a sodium hypochlorite solution (NaOCl, 150 ppm free available chlorine) for use as potential sanitizers of cucumbers and strawberries. AcEW and NaOCl reduced the aerobic mesophiles naturally present on cucumbers within 10 min by 1.4 and 1.2 log CFU per cucumber, respectively. The reduction by ozonated water (0.7 log CFU per cucumber) was significantly less than that of AcEW or NaOCl (P < 0.05). Cucumbers washed in alkaline electrolyzed water for 5 min and then treated with AcEW for 5 min showed a reduction in aerobic mesophiles that was at least 2 log CFU per cucumber greater than that of other treatments (P < 0.05). This treatment was also effective in reducing levels of coliform bacteria and fungi associated with cucumbers. All treatments offered greater microbial reduction on the cucumber surface than in the cucumber homogenate. Aerobic mesophiles associated with strawberries were reduced by less than 1 log CFU per strawberry after each treatment. Coliform bacteria and fungi associated with strawberries were reduced by 1.0 to 1.5 log CFU per strawberry after each treatment. Microbial reduction was approximately 0.5 log CFU per strawberry greater on the strawberry surface than in the strawberry homogenate. However, neither treatment was able to completely inactivate or remove the microorganisms from the surface of the cucumber or strawberry.

Source: Abstract

5.12 Lettuce


Source:


Source:


Source:
Source:

Source:

Source:

Source:

5.13 Alfalfa seeds

Source:

5.14 Rice

Source:

5.15 Tofu

Source:

5.16 Wheat noodles

Source:

6 Animals

6.1 General agriculture and food

Microbial control of postharvest diseases has been extensively studied and appears to be a viable technology. Food safety must be ensured at each postharvest processing step, including handling, washing of raw materials, cleaning of utensils and pipelines, and packaging. Several commercial products are available for this purpose. The time is ripe for developing new techniques and technologies. The use of electrolyzed water (EW) is the product of a new concept developed in Japan, which is now gaining popularity in other countries. Little is known about the principle behind its sterilizing effect, but it has been shown to have significant bactericidal and virucidal and moderate fungicidal properties. Some studies have been carried out in Japan, China, and the USA on the pre- and postharvest application of EW in the field of food processing. EW may be produced using common salt and an apparatus connected to a power source. As the size of the machine is quite small, the water can be manufactured on-site. Studies have been carried out on the use of EW as a sanitizer for fruits, utensils, and cutting boards. It can also be used as a fungicide during postharvest processing of fruits and vegetables, and as a sanitizer for washing the carcasses of meat and poultry. It is cost-effective and environment-friendly. The use of EW is an emerging technology with considerable potential.  
Source: 

6.2 Cattle & Beef

Source:

Source:
Source:

Source:

Source:

Source: pdf

Source:


Source:

Source:

To determine the principal points of microbial contamination of carcasses during beef carcass dressing in Northern Ireland, 190 carcasses were sampled by swabbing 1,000 cm² of the brisket. A detailed survey of one abattoir was initially conducted, with sampling of a total of 100 carcasses immediately after hide removal (H), after carcass splitting (S), and immediately after washing (W) before dispatch to the chiller. The total bacterial counts after incubation at both 22 and 37 degrees C indicated that there was no significant increase in the numbers of bacteria after the first sampling point, H (P > 0.05). To determine whether this was the case in the majority of Northern Ireland abattoirs, 15 carcasses were then sampled at each of an additional six abattoirs, at points H and W only. Total bacterial counts were significantly higher (P < 0.05) at H than at W, indicating that hide pulling was the major point of bacterial contamination of beef carcasses and hence a critical control point for the final microbiological quality of the carcasses. Mean counts of Enterobacteriaceae at both incubation temperatures were very low (< 10 CFU/cm²) but were higher at W than at H, probably indicating that washing was redistributing bacteria from the posterior to the anterior region.
Source: Abstract

6.3 Pigs and Pork

To date, the effectiveness of electrolyzed oxidizing (EO) water against bacteria associated with fresh pork has not been determined. Using a hand-held, food-grade garden sprayer, distilled water (W), chlorinated water (Cl; 25 ppm), 2% lactic acid (LA), acidic EO water (EOA), or “aged” acidic EO water (AEAO; stored at 4 °C for 24 h) was sprayed (15 s) onto pork bellies inoculated with feces containing Listeria monocytogenes (LM), Salmonella typhimurium (ST), and Campylobacter coli (CC). Remaining bacterial populations were determined immediately following treatment, after 2 days of aerobic storage, and again after 5 days of vacuum-packaged, refrigerated storage (day 7). While LA and EOA significantly reduced (p<0.05) populations of CC at days 0 and 7, there was no significant difference (p>0.05) between antimicrobial treatments when applied to pork inoculated with ST or LM. This study demonstrates that a 15-s spray with EOA has the ability to reduce CC associated with fresh pork surfaces. However, longer contact times may be necessary to reduce other microbial contaminants.
Source: Abstract

6.4 Poultry - Chickens

Lots of microorganisms exist in layer houses can cause bird diseases and worker health concerns. Spraying chemical disinfectants is an effective way to decontaminate pathogenic microorganisms in the air and on surfaces in poultry houses. Slightly acidic electrolyzed water (SAEW, pH 5.0-6.5) is an ideal, environmentally friendly broad-spectrum disinfector to prevent and control bacterial or viral infection in layer farms. The purpose of this work was to investigate the cleaning effectiveness of SAEW for inactivating the microbes in layer houses. The effect of SAEW was evaluated by solid materials and surface disinfection in a hen house. Results indicate
that SAOW with an available chlorine concentration of 250 mg/L, pH value of 6.19, and oxygen reduction potential of 974 mV inactivated 100% of bacteria and fungi in solid materials (dusts, feces, feather, and feed), which is more efficient than common chemical disinfectant such as benzalkonium chloride solution (1:1,000 vol/vol) and povidone-iodine solution (1:1,000 vol/vol). Also, it significantly reduced the microbes on the equipment or facility surfaces (P < 0.05), including floor, wall, feed trough, and water pipe surfaces. Moreover, SAOW effectively decreased the survival rates of Salmonella and Escherichia coli by 21 and 16 percentage points. In addition, spraying the target with tap water before disinfection plays an important role in spray disinfection.

Source: Abstract

NB: This one is very interesting and not only shows the Chinese are into this area but that they are investigating lots of possible applications.

The use of electrolyzed water for washing and sanitizing eggshells and an egg washer was evaluated for its effectiveness at a Grade & Packing Center adjacent to a poultry farm for a period of nine months. The test results indicate improvement in sanitation control. Dissolving yolk of broken eggs with electrolyzed alkaline water followed by sanitizing with electrolyzed acidic water produced favorable effects. Also, the use of electrolyzed water has an advantage in that it simplifies the conventional washing and sanitizing process and motivates operators to employ the process more frequently. This is the basis of the next thing for the improvement of sanitation control.

Source: Abstract pdf

Campylobacter infections pose a serious public health problem in Belgium. Poultry meat is most likely responsible for 40% of human campylobacteriosis cases in Belgium. On a yearly basis, consumption of poultry meat causes at least 22,000 campylobacteriosis cases, with a cost of illness of Euro 10.9 million. Several intervention measures have been proposed in literature, aiming to reduce the contamination of poultry meat and thus lead to significant reductions of human campylobacteriosis cases. This study aimed to evaluate the cost-benefit ratio, i.e., the ratio of reduced costs of illness on intervention costs of various intervention measures. These measures were selected by representatives from the poultry meat sector and experts in the field of poultry science. The selection comprised measures at the farm level (phage therapy), at the processing plant (spraying of carcasses with lactic acid or electrolyzed oxidizing water, crust freezing, or irradiation), and at the consumer level (improving kitchen hygiene and application of home freezing). Among these measures, the decontamination of carcasses with electrolyzed oxidizing water applied in the processing plant was the most efficient (17.66), followed by the use of lactic acid (4.06). In addition, phage therapy generated a positive cost-benefit ratio (2.54). Irradiation indicated the highest efficacy, but its cost-benefit ratio was rather low (0.31). There seems to be less gain by trying to improve food handling in the kitchen. The cost to reach consumers is large, while only a very limited fraction of the consumers is willing to change its behavior. The outcome of this study poses valuable information for future risk-management decisions in Belgium.


Foodborne pathogens in cell suspensions or attached to surfaces can be reduced by electrolyzed oxidizing (EO) water; however, the use of EO water against pathogens associated with poultry has not been explored. In this study, acidic EO water (EO-A; pH 2.6, chlorine (Cl) 20 to 50 ppm, and oxidation-reduction potential (ORP) of 1,150 mV), basic EO water (EO-B; pH 11.6, ORP of -795 mV), Cl, ozonated water (O2), acetic acid (AA), or trisodium phosphate (TSP) was applied to broiler carcasses inoculated with Salmonella Typhimurium (ST) and submerged (4 C, 45 min), spray-washed (85 psi, 25 C, 15 s), or subjected to multiple interventions (EO-B spray, immersed in EO-A; AA or TSP spray, immersed in CL). Remaining bacterial populations were determined and compared at Day 0 and 7 of aerobic, refrigerated storage. At Day 0, submersion in TSP and AA reduced ST 1.41 log10, whereas EO-A water reduced ST approximately 0.86 log10. After 7 d of storage, EO-A water, O2, TSP, and AA reduced ST, with detection only after selective enrichment. Spray-washing treatments with any of the compounds did not reduce ST at Day 0. After 7 d of storage, TSP, AA, and EO-A water reduced ST 2.17, 2.31, and 1.06 log10, respectively. ST was reduced 2.11 log10 immediately following the multiple interventions, 3.81 log10 after 7 d of storage. Although effective against ST, TSP and AA are costly and adversely affect the environment. This study demonstrates that EO water can reduce ST on poultry surfaces following extended refrigerated storage.

Source: Abstract

This study was undertaken to investigate the efficacy of alkaline and acidic electrolyzed (EO) water in preventing and removing fecal contaminants and killing Campylobacter jejuni on poultry carcasses under simulated industrial processing conditions. New York dressed and defeathered chicken carcasses spot-inoculated with cecal material or C. jejuni were subjected to spraying treatment with alkaline EO or 10% trisodium phosphate (TSP)water or combinations of spraying and immersion treatment with acidic EO and chlorinated water, respectively. Prespraying chicken carcasses with alkaline EO water significantly lowered cecal material attachment scores (3.77) than tap water (4.07) and 10% TSP (4.08) upon treatment of the dorsal area. Combinations of pre- and postspraying were significantly more effective than postspraying only, especially when using alkaline EO water in removing fecal materials on the surface of chicken carcasses. Although treatment by immersion only in EO and chlorinated water significantly reduced the initial population (4.92 log10 cfu/g) of C. jejuni by 2.33 and 2.05 log10 cfu/g, respectively, combinations of spraying and immersion treatment did not improve the bacterial effect of sanitizers. The results indicated that alkaline EO water might provide an alternative to TSP in preventing attachment and removal.
of feces on the surface of chicken carcasses. The results also suggested that chicken carcasses containing pathogenic microorganisms may contribute to the cross-contamination of whole batches of chickens during processing in the chiller tank and afterward.

Source: Abstract

The effect of acidic, electrolyzed oxidizing (EO) water and chlorinated water on the spoilage microflora of processed broiler carcasses was examined. Carcasses were sprayed for 5 s at 80 psi with tap, chlorinated, or EO water in an inside-outside bird washer. Treated carcasses were then stored at 4 degrees C for 0, 3, 7, or 14 d, and the microbial flora of the carcasses was sampled using the whole-carcass rinse procedure. Populations of psychrotrophic bacteria and yeasts in the carcass rinsates were enumerated. Results indicated that immediately after spraying the carcasses, significantly fewer psychrotrophic bacteria were recovered from carcasses sprayed with chlorinated or EO water than from carcasses sprayed with tapwater. Furthermore, significantly fewer yeasts were recovered from carcasses sprayed with EO water than from carcasses sprayed with tap or chlorinated water. The population of psychrotrophic bacteria and yeasts increased on all carcasses during refrigerated storage. However, after 14 d of storage, significantly fewer psychrotrophic bacteria and yeasts were recovered from carcasses sprayed with EO water than from carcasses sprayed with tap or chlorinated water, and significantly fewer microorganisms were recovered from carcasses sprayed with chlorinated water than from carcasses sprayed with tap water. Pseudomonas spp. and Candida spp. were the primary microbial isolates recovered from the broiler carcasses. Findings from the present study indicate that EO water can effectively be used in inside-outside bird washers to decrease the population of spoilage bacteria and yeasts on processed broiler carcasses.

Source: Abstract

Research was conducted to compare the effectiveness of electrolyzed oxidative (EO) water applied using an electrostatic spraying system (ESS) for killing populations of bacteria that are of concern to the poultry industry. Populations of pathogenic bacteria (Salmonella typhimurium, Staphylococcus aureus, and Listeria monocytogenes), and the indicator bacterium Escherichia coli were applied to eggs and allowed to attach for 1 h. EO water completely eliminated all Salmonella typhimurium on 3, 7, 1, and 8 out of 15 eggs in Repetitions (Rep) 1, 2, 3, and 4, respectively, even when very high inoculations were used. EO water completely eliminated all Staphylococcus aureus on 12, 11, 12, and 11 out of 15 eggs in Rep 1, 2, 3, and 4, respectively. EO water completely eliminated all Listeria monocytogenes on 8, 13, 12, and 14 out of 15 eggs in Reps 1, 2, 3, and 4, respectively. EO water completely eliminated all Escherichia coli on 9, 11, 15, and 11 out of 15 eggs in Reps 1, 2, 3, and 4, respectively. Even when very high concentrations of bacteria were inoculated onto eggs (many times higher than would be encountered in industrial situations), EO water was found to be effective when used in conjunction with electrostatic spraying for eliminating pathogenic and indicator populations of bacteria from hatching eggs.

Source: Abstract

The present study was designed to achieve a reduction of reactive oxygen species (ROS)-induced oxidative damage to skeletal muscle and to improve the performance of broiler chickens exposed to chronic heat stress. 2. Chickens were given a control diet with normal drinking water, or diets supplemented with cashew nut shell liquid (CNSL) or grape seed extract (GSE), or a control diet with electrolysed reduced water (ERW) for 19 d after hatch. Thereafter, chickens were exposed to a temperature of either 34°C continuously for a period of 5 d, or maintained at 24°C, on the same diets. 3. The control broilers exposed to 34°C showed decreased weight gain and feed consumption and slightly increased ROS production and malondialdehyde (MDA) concentrations in skeletal muscle. The chickens exposed to 34°C and supplemented with ERW showed significantly improved growth performance and lower ROS production and MDA contents in tissues than control broilers exposed to 34°C. Following heat exposure, CNSL chicken broilers performed better with respect to weight gain and feed consumption, but still showed elevated ROS production and skeletal muscle oxidative damage. GSE chickens did not exhibit improved performance or reduced skeletal muscle oxidative damage. 4. In conclusion, this study suggests that ERW could partially inhibit ROS-induced oxidative damage to skeletal muscle and improve growth performance in broiler chickens under medium-term chronic heat treatment.

Source: Abstract

The effectiveness of electrolyzed (EO) water for killing Campylobacter jejuni on poultry was evaluated. Complete inactivation of C. jejuni in pure culture occurred within 10 s after exposure to EO or chlorinated water, both of which contained 50 mg/l of residual chlorine. A strong bactericidal activity was also observed on the diluted EO water (containing 25 mg/l of residual chlorine) and the mean population of C. jejuni was reduced to less than 10 CFU/ml (detected only by enrichment for 48 h) after 10-s treatment. The diluted chlorine water (25 mg/l residual chlorine) was less effective than the diluted EO water for inactivation of C. jejuni. EO water was further evaluated for its effectiveness in reducing C. jejuni on chicken during washing. EO water treatment was equally effective as chlorinated water and both achieved reduction of C. jejuni by about 3 log10 CFU/g on chicken, whereas deionized water (control) treatment resulted in only 1 log10 CFU/g reduction. No viable cells of C. jejuni were recovered in EO and chlorinated water after washing treatment, whereas high populations of C. jejuni (4 log10 CFU/ml) were recovered in the wash solution after the control treatment. Our study demonstrated that EO water was very effective not in reducing the populations of C. jejuni on chicken, but also could prevent cross-contamination of processing environments.

The efficacy of acidic electrolyzed (EO) water produced at three levels of total available chlorine (16, 41, and 77 mg/liter) and chlorinated water with 45 and 200 mg/liter of residual chlorine was investigated for inactivating *Salmonella Enteritidis* and *Listeria monocytogenes* on shell eggs. An increasing reduction in *Listeria* population was observed with increasing chlorine concentration from 16 to 77 mg/liter and treatment time from 1 to 5 min, resulting in a maximal reduction of 3.70 log CFU per shell egg compared with a deionized water wash for 5 min. There was no significant difference in antibacterial activities against *Salmonella* and *Listeria* at the same treatment time between 45 mg/liter of chlorinated water and 14-A acidic EO water treatment (**P** > 0.05). Chlorinated water (200 mg/liter) wash for 3 and 5 min was the most effective treatment; it reduced mean populations of *Listeria* and *Salmonella* on inoculated eggs by 4.89 and 3.83 log CFU/shell egg, respectively. However, reductions (log CFU/shell egg) of *Listeria* (4.39) and *Salmonella* (3.66) by 1-min alkaline EO water treatment followed by another 1 min of 14-A acidic EO water (41 mg/liter chlorine) treatment had a similar reduction to the 1-min 200 mg/liter chlorinated water treatment for *Listeria* (4.01) and *Salmonella* (3.81). This study demonstrated that a combination of alkaline and acidic EO water wash is equivalent to 200 mg/liter of chlorinated water wash for reducing populations of *Salmonella Enteritidis* and *L. monocytogenes* on shell eggs.


Evaluation of “Neutral Electrolyzed Water” Disinfectant on Inactivation of Avian Influenza Virus and Other Avian Viruses

The Avian Virology Section of the Animal Diagnostic Laboratory at Penn State University has conducted a research study on the “Anolyte Water” or “Neutral Electrolyzed Water” disinfectant solution on inactivation of avian influenza virus and other important avian viruses. The AKUA KT Inc. of South Korea has provided newly produced and fresh Anolyte Water solutions for this research study. Preliminary results indicated that the Anolyte Water solution effectively inactivated or killed a variety of avian respiratory and enteric viruses tested including avian influenza virus (AIV), Paramyxoviruses (PMV) and Newcastle disease virus (NDV, or PMV-1), infectious bronchitis virus (IBV), fowl adenovirus (FAV), avian reovirus, and pigeon herpesvirus. Effective dilutions of the Anolyte Water were found between 1:2 and 1:5 with sterile distilled water or deionized water.

Source: [pdf](#)


During commercial processing, eggs are washed in an alkaline detergent and then rinsed with chlorine to reduce dirt, debris, and microorganism levels. The alkaline and acidic fractions of electrolyzed oxidizing (EO) water have the ability to fit into the 2-step commercial egg washing process easily if proven to be effective. Therefore, the efficacy of EO water to decontaminate *Salmonella Enteritidis* and *Escherichia coli* K12 on artificially inoculated shell eggs was investigated. For the in vitro study, eggs were soaked in alkaline EO water followed by soaking in acidic EO water at various temperatures and times. Treated eggs showed a reduction in population between > or = 0.6 to > or =2.6 log10 cfu/g of shell for *S. Enteritidis* and > or =0.9 and > or =2.6 log10 for *E. coli* K12. Log10 reductions of 1.7 and 2.0 for *S. Enteritidis* and *E. coli* K12, respectively, were observed for typical commercial detergent-sanitizer treatments, whereas log10 reductions of > or =2.1 and > or =2.3 for *S. Enteritidis* and *E. coli* K12, respectively, were achieved using the EO water treatment. For the pilot-scale study, both fractions of EO water were compared with the detergent-sanitizer treatment using *E. coli* K12. Log10 reductions of > or =2.98 and > or =2.91 were found using the EO water treatment and the detergent-sanitizer treatment, respectively. The effects of 2 treatments on egg quality were investigated. EO water and the detergent-sanitizer treatments did not significantly affect albumen height or eggshell strength; however, there were significant effects on cuticle presence. These results indicate that EO water has the potential to be used as a sanitizing agent for the egg washing process.

Source: [Abstract pdf](#)

### 6.5 Fish and Seafood


For reducing bacterial contamination, electrolyzed oxidizing water (EO water) has been used to reduce microbial population on seafood and platform of fish retailer. The specimens of tilapia were inoculated with *Escherichia coli* and *Vibrio parahaemolyticus*, and then soaked into EO water for up to 10 min. EO water achieved additional 0.7logCFU/cm2 reduction than tap water on *E. coli* after 1 min treatment and additional treatment time did not achieved additional reduction. EO water treatment also reduced *V. parahaemolyticus*, by 1.510g CFU/cm2 after 5 min treatment and achieved 2.6logCFU/cm2 reduction after 10 min. The pathogenic bacteria were not detected in EO water after soaking treatment. In addition, EO water could effectively disinfect the platform of fish retailer in traditional markets and fish markets.

Source: [pdf](#)


Contamination of *Vibrio parahaemolyticus* and *Vibrio vulnificus* in oysters is a food safety concern. This study investigated effects of electrolyzed oxidizing (EO) water treatment on reducing *V. parahaemolyticus* and *V. vulnificus* in laboratory-contaminated oysters. EO water exhibited strong antibacterial activity against *V. parahaemolyticus* and *V. vulnificus* in pure cultures. Populations of *V. parahaemolyticus* (8.74 x 10(7) CFU/ml) and *V. vulnificus* (8.69 x 10(7) CFU/ml) decreased quickly in EO water containing 0.5% NaCl to nondetectable levels (> 6.6 log reductions) within 15 s. Freshly harvested Pacific oysters were inoculated with a five-strain cocktail of *V. parahaemolyticus* and *V. vulnificus* in successive experiments and EO water treatment was conducted. The results of this study demonstrated that EO water could effectively reduce the populations of *V. parahaemolyticus* and *V. vulnificus* in raw oysters.

Source: [pdf](#)

Among different fish slices used for sashimi preparation, tuna is the most popular and preferable fish type for Taiwanese people. To improve the hygienic quality of fish slices, electrolyzed (EO) water containing 10, 50, and 100 mg/L chloride, was used in combination with CO gas treatment. Effect of different treatment on aerobic plate count (APC), volatile basic nitrogen (VBN), K value, and Hunter L*, a*, b* values of yellow-fin tuna steak during storage (4 °C and ~20 °C) were evaluated. It was found that APC, VBN, and K values increased with storage time for all treatment. Except for K value, APC and VBN of tuna steak treated with the combination of more than 50 mg/L chlorine EO water and CO gas had the lowest value after 8 d of refrigerated storage. Hunter a* value of tuna steak treated with only CO gas was the highest, followed by those treated with EO water and CO gas. These results demonstrated that EO water containing 50 mg/L chlorine combined with CO gas treatment in tuna fish steak would be an effective method for enhancing the hygienic quality and freshness for tuna meat and extending refrigerated storage time. Tuna treated with EO water containing 100 mg/L chlorine and CO gas combination had the lowest APC immediately after treatment and reduced further to below detection limit after 1 mo frozen storage at ~20 °C.


The effects of electrolyzed oxidizing (EO) water on reducing Listeria monocytogenes contamination on seafood processing surfaces were studied. Chips (5 x 5 cm(2)) of stainless steel sheet (SS), ceramic tile (CT), and floor tile (FT) with and without crabmeat residue on the surface were inoculated with L. monocytogenes and soaked in tap or EO water for 5 min. Viable cells of L. monocytogenes were detected on all chip surfaces with or without crabmeat residue after being held at room temperature for 1 h. Soaking contaminated chips in tap water resulted in small-degree reductions of the organism (0.40-0.66 log cfu/chip on clean surfaces and 0.78-1.33 log cfu/chip on dirty surfaces). Treatments of EO water significantly (p<0.05) reduced L. monocytogenes on clean surfaces (3.73 log on SS, 4.24 log on CT, and 5.12 log on FT). Presence of crabmeat residue on chip surfaces reduced the effectiveness of EO water on inactivating Listeria cells. However, treatments of EO water also resulted in significant reductions of L. monocytogenes on dirty surfaces (2.33 log on SS and CT and 1.52 log on FT) when compared with tap water treatments. The antimicrobial activity of EO water was positively correlated with its chlorine content. High oxidation-reduction potential (ORP) of EO water also contributed significantly to its antimicrobial activity against L. monocytogenes. EO water was more effective than chlorine water on inactivating L. monocytogenes on surfaces and could be used as a chlorine alternative for sanitation purpose. Application of EO water following a thorough cleaning process could greatly reduce L. monocytogenes contamination in seafood processing environments.


Food processing gloves are typically used to prevent cross-contamination during food preparation. However, gloves can be contaminated with microorganisms and become a source of contamination. This study investigated the survival of Listeria monocytogenes on gloves and determined the efficacy of electrolyzed oxidizing (EO) water for reducing L. monocytogenes contamination on seafood processing gloves. Three types of reusable gloves (natural rubber latex, natural latex, and nitrile) and two types of disposable gloves (latex and nitrile) were cut into small pieces (4 x 4 cm(2)) and inoculated with 5-strain L. monocytogenes cocktail (5.1 x 10(7) CFU/cm(2)) with and without shrimp meat residue attached to surfaces. L. monocytogenes did not survive well on clean reusable gloves and its populations decreased rapidly to non-detectable levels within 30 min at room temperature. However, high levels of Listeria cells were recovered from clean disposable gloves after 30 min of inoculation. Presence of shrimp meat residue on gloves enhanced the survival of L. monocytogenes. Cells of L. monocytogenes were detected on both reusable and disposable gloves even after 2 h at room temperature. Soaking inoculated gloves in EO water at room temperature for 5 min completely eliminated L. monocytogenes on clean gloves (>4.46 log CFU/cm(2) reductions) and significantly (p<0.05) reduced the contamination on soil-containing gloves when compared with tap water treatment. EO water could be used as a sanitizer to reduce L. monocytogenes contamination on gloves and reduce the possibility of transferring L. monocytogenes from gloves to RTE seafoods.


Raw fish is prone to the risk of microbial outbreaks due to contamination by pathogenic microorganisms, such as Escherichia coli O157:H7 and Listeria monocytogenes. Therefore, it is essential to treat raw fish to inactivate pathogenic microorganisms. Electrolyzed Oxidizing Water (EO) is a novel antimicrobial agent containing acidic solution with a pH of 2.6, Oxidation Reduction Potential (ORP) of 1150 mV, and 70–90 ppm free chlorine, and alkaline solution with a pH of 11.4 and ORP of ~795 mV. This study was undertaken to evaluate the efficacy of acidic EO water treatment and alkaline EO water treatment followed by acidic EO water treatment at various temperatures for the inactivation of E. coli O157:H7 and L. monocytogenes Scott A on the muscle and skin surfaces of inoculated salmon fillets. Inoculated
6.5.8 Disinfection and general properties

7. Disinfection and general properties

7.1 General

7.1.1 Stability of electrolyzed water and its efficacy against cell suspensions of Salmonella Typhimurium and Listeria monocytogenes.


Electrolyzed oxidizing (EO) water has proved to be effective against foodborne pathogens attached to cutting boards and poultry surfaces and against spoilage organisms on vegetables; however, its levels of effectiveness against Listeria monocytogenes and Salmonella Typhimurium in cell suspensions have not been compared with those of other treatments. In this study, the oxidation reduction potentials (ORPs), chlorine concentrations, and pH of acidic and basic EO water were monitored for 3 days at 4 and 25 degrees C after generation. There were no differences between the pHs or ORPs of acidic and basic EO waters stored at 4 or 25 degrees C. However, the free chlorine concentration in acidic EO water stored at 4 degrees C increased after 24 h. In contrast, the free chlorine concentration in acidic EO water stored at 25 degrees C decreased after one day. Cell suspensions of Salmonella Typhimurium and L. monocytogenes were treated with distilled water, chlorinated water (20 ppm), acidified chlorinated water (20 ppm, 4.5 pH), acidic EO water (EOA), basic EO water (EOB), or acidic EO water that was “aged” at 4 degrees C for 24 h (AEFA) for up to 15 min at either 4 or 25 degrees C. The largest reductions observed were those following treatments carried out at 25 degrees C. EOA and AEOA treatments at both temperatures significantly reduced Salmonella Typhimurium populations by > 8 log10 CFU/ml. EOA and AEOA treatments effectively reduced L. monocytogenes populations by > 8 log10 CFU/ml at 25 degrees C. These results demonstrate the stability of EO water under different conditions and that EO water effectively reduced Salmonella Typhimurium and L. monocytogenes populations in cell suspensions. Source


Glutaraldehyde is used as a disinfectant for endoscopes, but is an irritant and so should be replaced by an alternative. Electrolysed acid water (EAW) has a bactericidal effect, and an endoscopic washing device using EAW has been developed in Japan. To investigate the effect


AIMS: To evaluate the efficacy of electrolysed NaCl solutions (EW) for disinfecting bacterial isolates from carp, and the potential application of EW to reducing the bacterial load in whole carp and carp fillets.

METHODS AND RESULTS: EW was produced by using a two-compartment batch-type electrolysed apparatus. Pure cultures (in vitro), whole carp (skin surface) and carp fillets were treated with EW to detect its antimicrobial effects. The anodic solution [EW (+)] completely inhibited growth of the isolates. Furthermore, dipping the fish samples in EW (+) reduced the mean total count of aerobic bacteria on the skin of whole carp and in fillets by 2.8 and 2.0 log10(10), respectively. The cathodic solution [EW (-)] also reduced growth of the isolates from carp by ca 1.0 log10(10). Moreover, the total counts of aerobic bacteria in whole carp (on the skin) and fillets were reduced by 1.28 and 0.82 log10(10), respectively.

CONCLUSIONS: EW (+) has a strong bactericidal effect on bacteria isolated from carp.

SIGNIFICANCE AND IMPACT OF THE STUDY: Treatment with EW (+) could extend the shelf life of these fish. Source


The effects of electrolyzed water ice (EW-ice), compared with traditional tap water ice (TW-ice), on the microbiological, chemical, and sensory quality of Pacific saury (Cololabis saira) stored for a period of up to 30 days at 4 degrees C were evaluated. EW-ice with active chlorine at a concentration of 34 mg/kg was prepared from weak acidic electrolyzed water, whose pH, oxidation-reduction potential, and chlorine content were 5, 866 mV, and 47 mg/liter, respectively. Microbiological analysis showed that EW-ice, compared with TW-ice, markedly inhibited the growth of both aerobic and psychrotrophic bacteria in saury flesh during refrigerated storage, primarily because of the action of active chlorine. Chemical analysis revealed that EW-ice retarded the formation of volatile nitrogen and thiobarbituric acid-reactive substances and reduced the accumulation of alkaline compounds in the fish flesh in comparison with TW-ice. Sensory analysis confirmed that the freshness of saury was better preserved in EW-ice than in TW-ice and showed that the saury stored in EW-ice had a shelf life that was about 4 to 5 days longer than the fish stored in TW-ice. Source
of EAW on the infectivity of viruses, we treated duck hepatitis B virus (DHBV), which has similar properties to hepatitis B virus, with EAW, and determined the number of remaining infectious virus particles in a bioassay system. One-day-old Pekin ducks were inoculated with duck serum containing 10(5.5) ID(50) DHBV; the serum had previously been incubated with 100 volumes of EAW or ion-exchanged water at room temperature for 7 min. DHBV infection was indicated by detection of viral DNA in duck serum samples 1-8 weeks after inoculation. Treatment of serum with EAW diminished DHBV infectivity whereas treatment with ion-exchanged water did not. The virus load was estimated to have been reduced to 10(1)-10(3) ID(50) during the first 1 min and to <10(0.5) ID(50) in the next 6 min of incubation when compared with the control. Thus, EAW directly inactivates DHBV and its clinical application is recommended. \[\text{Source}\]


The bactericidal activity on \textit{Listeria} spp. of nine disinfectants used in the food industry was studied by previously published methods. The disinfectants were diluted to the test concentration in sterile standard hard water. Various types of chemical agents were evaluated, including phenolic compounds, alcohols, quaternary ammonium compounds, surface-active agents, aldehydes and disinfectant tablets. The following strains isolated from cheese were studied: \textit{Listeria innocua}, \textit{L. welshimeri}, \textit{L. monocytogenes} 1/2a, 1/2b, 1/2c and 4b. The results show that the listerias are not particularly resistant to disinfectants but the efficacy of some agents is affected by organic matter.


The study is designed to investigate bactericidal actions of electrolyzed oxidizing water on hospital infections. Ten of the most common opportunistic pathogens are used for this study. Cultures are inoculated in 4.5 ml of electrolyzed oxidizing (EO) water or 4.5 ml of sterile deionized water (control), and incubated for 0, 0.5, and 5 min at room temperature. At the exposure time of 50 s the EO water completely inactivates all of the bacterial strains, with the exception of vegetative cells and spores of bacilli which need 5 min to be killed. The results indicate that electrolyzed oxidizing water may be a useful disinfectant for hospital infections, but its clinical application has still to be evaluated. \[\text{Source}\]


The efficacy of electrolyzed oxidizing water for inactivating \textit{Escherichia coli} O157:H7, \textit{Salmonella enteritidis}, and \textit{Listeria monocytogenes} was evaluated. A five-strain mixture of \textit{E. coli} O157:H7, \textit{S. enteritidis}, or \textit{L. monocytogenes} of approximately 10(8) CFU/ml was inoculated in 9 ml of electrolyzed oxidizing water (treatment) or 9 ml of sterile, deionized water (control) and incubated at 0, 5, 10, and 15 min; at 35 degrees C for 0, 2, 4, and 6 min; or at 45 degrees C for 0, 2, 3, 5, and 5 min. The surviving population of each pathogen at each sampling time was determined on tryptic soy agar. At 4 or 23 degrees C, an exposure time of 5 min reduced the populations of all three pathogens in the treatment samples by approximately 7 log CFU/ml with complete inactivation by 10 min of exposure. A reduction of log CFU/ml in the levels of the three pathogens occurred in the treatment samples incubated for 1 min at 45 degrees C or for 2 min at 35 degrees C. The bacterial counts of all three pathogens in control samples remained the same throughout the incubation at all four temperatures. Results indicate that electrolyzed oxidizing water may be a useful disinfectant, but appropriate applications need to be validated. \[\text{Source}\]

7.1.6 Different responses of planktonic and attached \textit{Bacillus subtilis} and \textit{Pseudomonas fluorescens} to sanitizer treatment. Lindsay, D., and A. von Holy. 1999. \textit{J. Food Prot.} 62:368–379

Three commercial sanitizers containing iodophor (I), peracetic acid/ hydrogen peroxide (PAH), or chlorhexidine gluconate (CG) were evaluated in vitro against planktonic and sessile \textit{Bacillus} subtilis or \textit{Pseudomonas} fluorescens cells grown in Standard One Nutrient Broth. Sessile cells were attached to stainless steel or polyurethane test surfaces. Planktonic and attached cells of both bacteria were enumerated by plate counts after sanitizer treatment for 1, 3, or 5 min. Sessile cells were dislodged from test surfaces by shaking with beads. Cell morphologies were monitored by scanning electron microscopy (SEM). Attached \textit{B. subtilis} and \textit{P. fluorescens} cells on both surface types were less susceptible to all three sanitizers than their planktonic counterparts. PAH, I, and CG were equally effective against planktonic \textit{P. fluorescens} cells, which were reduced by 99.99% after 1, 3, and 5 min exposure. PAH was the only sanitizer effective against attached \textit{P. fluorescens} cells on both surface types; it reduced counts by < or < 99.9% after 1, 3, and 5 min exposure. PAH was also the most effective sanitizer against planktonic \textit{B. subtilis} cells, reducing counts by 99.9% after 1, 3, and 5 min. Sessile \textit{B. subtilis} cells on both surface types were the least susceptible to all sanitizers; counts were reduced by only 99.5% or less after exposure to PAH for 5 min. SEM revealed that planktonic and attached cells of both bacteria exhibited symptoms of surface roughness, indentations, and shape distortions after treatment with any of the sanitizers. \[\text{Source}\]


Electrolysis of a 0.1% (17.1 mM) solution of NaCl using separate anode and cathode compartments gives rise to solutions containing active chemical species. The strongly acidic "anode solution" (EW+) has high levels of dissolved oxygen and available chlorine in a form of hypochlorous acid (HOCI) with a strong potential for sterilization, which we have investigated here. Exposure Aspergillus parasiticus at an initial density of 10(3) spores in 10 ml of a 50-fold volume (500 ml) of EW+ containing ca. 390 micromol HOCI for 15 min at room temperature resulted in a complete inhibition of fungal growth, whereas the cathode solution (EW-) had negligible inhibitory effects. Moreover, the mutagenicity of aflatoxin B(1) (AFB(1)) for \textit{Salmonella typhimurium} TA-98 and TA-100 strains was strongly reduced after AFB(1) exposure to the EW+ but not with the EW-. In high-performance liquid chromatography analysis, the peak corresponding to AFB(1) disappeared after treatment with the EW+, indicating decomposition of the aflatoxin. In contrast, the routinely used disinfectant sodium hypochlorite, NaOCI, of the same available chlorine content as that of EW+ but in a different chemical form, hypochlorite (OCl-) ion, did not decompose AFB(1) at pH 11. However, NaOCI did decompose AFB(1) at pH 3, which indicated that the principle chemical formula to

Electrolyzed anodic NaCl solutions (EW+), prepared by the electrolysis of 0.1% NaCl, have been shown to instantly inactivate most pathogens that cause food-borne disease. Elimination of food-borne pathogens does not necessarily guarantee food safety because enterotoxins produced by pathogens may remain active. We have tested whether EW+ can inactivate Staphylococcal enterotoxin A (SEA), one of the major enterotoxins responsible for food poisoning. Fixed quantities of SEA were mixed with increasing molar ratios of EW+ and SEA was evaluated by reversed-phase passive latex agglutination (RPLA) test, immunoassay, native polyacrylamide gel electrophoresis (PAGE), and amino acid analysis after 30 min incubations. Exposure of 70 ng, or 2.6 pmol, of SEA in 25 microl of PBS to a 10-fold volume of EW+, or ca. 64.6 x 10(3) fold molar excess of HOCI in EW+, caused a loss of immuno-reactivity between SEA and a specific anti-SEA antibody. Native PAGE indicated that EW+ caused fragmentation of SEA, and amino acid analysis indicated a loss in amino acid content, in particular Met, Tyr, Ile, Asn, and Asp. Staphylococcal enterotoxin-A excreted into culture broth was also inactivated by exposure to an excess molar ratio of EW+. Thus, EW+ may be a useful management tool to ensure food hygiene by food processing industries. [Source]


Recent foodborne outbreaks implicating spinach and lettuce have increased consumer concerns regarding the safety of fresh produce. While the most common commercial antimicrobial intervention for fresh produce is wash water containing 50 to 200 ppm chlorine, this study compares the effectiveness of acidified sodium chlorite, chlorine, and acidic electrolyzed water for inactivating Escherichia coli O157:H7, Salmonella, and Listeria monocytogenes inoculated onto leafy greens. Fresh mixed greens were left un inoculated or inoculated with approximately 6 log CFU/g of E. coli O157:H7, Salmonella, and L. monocytogenes and treated by immersion for 60 or 90 s in different wash solutions (1:150, wt/vol), including 50 ppm of chlorine solution added to pH 6.5, acidic electrolyzed water (pH 2.1 +/- 0.2, oxygen reduction potential of 1,100 mV, 30 to 35 ppm of free chlorine), and acidified sodium chlorite (1,200 ppm, pH 2.5). Samples were neutralized and homogenized. Bacterial survival was determined by standard spread plating on selective media. Each test case (organism x treatment x time) was replicated twice with five samples per replicate. There was no difference (P > or = 0.05) in the time of immersion on the antimicrobial effectiveness of the treatments. Furthermore, there was no difference (P > or = 0.05) in survival of the three organisms regardless of treatment or time. Acidified sodium chlorite, resulted in reductions in populations of 3 to 3.8 log CFU/g and was more effective than chlorinated water (2.1 to 2.8 log CFU/g reduction). These results provide the produce industry with important information to assist in selection of effective antimicrobial strategies. [Source]


To evaluate the potential of using electrolyzed oxidizing (EO) water for controlling Escherichia coli O157:H7 in water for livestock, the effects of water source, electrolyte concentration, dilution, storage conditions, and bacterial or fecal load on the oxidative reduction potential (ORP) and bactericidal activity of EO water were investigated. Anode and combined (7:3 anode:cathode, vol/vol) EO waters reduced the pH and increased the ORP of deionized water, whereas cathode EO water increased pH and lowered ORP. Minimum concentrations (vol/vol) of anode and combined EO waters required to kill 10(4) CFU/ml planktonic suspensions of E. coli O157:H7 strain H4420 were 0.5 and 2.0%, respectively. Cathode EO water did not inhibit H4420 at concentrations up to 16% (vol/vol). Higher concentrations of anode or combined EO water were required to elevate the ORP of irrigation or chlorinated tap water compared with that of deionized water. Addition of feces to EO water products (0.5% anode or 2.0% combined, vol/vol) significantly reduced (P < 0.001) their ORP values to < 700 mV in all water types. A relationship between ORP and bactericidal activity of EO water was observed. The dilute EO waters retained the capacity to eliminate a 10(4) CFU/ml inoculation of E. coli O157:H7 H4420 for at least 70 h regardless of exposure to UV light or storage temperature (4 versus 24 degrees C). At 95 h and beyond, UV exposure reduced ORP, significantly more so (P < 0.05) in open than in closed containers. Bactericidal activity of EO products (anode or combined) was lost in samples in which ORP value had fallen to < or = 848 mV. When stored in the dark, the diluted EO waters retained an ORP of > 848 mV and bactericidal efficacy for at least 125 h; with refrigeration (4 degrees C), these conditions were retained for at least 180 h. Results suggest that EO water may be an effective means by which to control E. coli O157:H7 in livestock water with low organic matter content.

Source: [Abstract]


An acidic solution (pH 2.5~2.6) with a high oxidation-reduction potential (ORP; about +1,170 mV) and an alkaline solution (pH 11.5~11.7) with a low ORP (about ~880mV) that resulted from electrolysis of 20 mM NaCl (dissolved in a pure water) were tested for their effect on the growth of Streptomyces spp. When spores (~2×107) were exposed to the electrolyzed solutions (2 ml) for 1 minute, colony formation was totally inhibited by the acidic solution, but little by the alkaline solution although extending the exposure (10 minutes) resulted in a...
marked inhibition. The 1 minute exposure to their mixture (1:1, v/v) showed a strong inhibition (but weaker than that of the acid solution). When the unexposed spores were streaked and incubated on ISP No. 4 (inorganic salts - starch medium) agar plate containing a cross density gradient of the acidic and alkaline solutions, a biased growth inhibition toward the acidic solution side was observed although the pH range of the acidic solution end of the plate was around 6.2. It seemed thus unlikely that low pH value contributed to the antimicrobial activity of the acidic solution. It was notable that S. griseus SS-1198 formed a unique morphology on the cross gradient plate. In addition, clear growth inhibition by the acidic solution was observed without direct contact with spores, probably because of chlorine gas release. Acidic solutions (pH 2.6–2.7) resulting from the electrolysis of 20 mM of Na2SO4 show no significant antimicrobial activity when tested by the cross gradient plate method. It thus seemed likely that chlorine played a key role for the antimicrobial activity of the acidic electrolyzed NaCl solution.

Source: Abstract


Soft oxidized water (SOW) is produced by electrolysis of water with NaCl and HCl. It has been reported that SOW has bactericidal effects on oral microorganisms. Therefore, SOW is considered to be useful for the control of plaque formation. However, when SOW is used for the control of plaque formation, the influences of storage condi-tions and saliva may cause qualitative changes in SOW. When SOW was stored in sealed and shaded bottles at 4°C or room temperature or in sealed bottles at room temperature, the temporal changes of pH, oxidation-reduction potential (ORP), chlorine concentration and bactericidal effects on three species of oral microorganisms were examined. In order to investigate the changes of SOW following contact with saliva, saliva was added to SOW, and measured in the same manner. Hard oxidized water (HOW) was also examined in the same way. Both SOW and HOW stored in sealed and shaded bottles at 4°C showed slight changes in pH, ORP, and chlorine concentration. While SOW retained the same bactericidal effect during the whole experimental period, the bactericidal effect of HOW decreased with time. When saliva was added to SOW or HOW, the pH, ORP, and chlorine concentration were significantly changed, but the bactericidal effect of SOW was unchanged. In conclusion, with both SOW and HOW the best storage condition is sealed and shaded bottles at 4°C. When saliva was added to SOW or HOW, the results indicated that SOW retained better bactericidal effects than HOW.

Source: Abstract


Hydrated pollen of Nicotiana tabacum L. (var. xanthi nc) was exposed to different concentrations of several volatile organic compounds. The germination rate of the pollen was determined by applying a modified test procedure originally developed by Kappler and Kristen (1990). A stimulation of pollen germination resulting through a rise in pCO2 was avoided by using a short exposure period. In the series of chlorinated ethanes, the ED50 (and ED25) values decrease with increasing number of chlorine atoms, which are correlated to a rise of the octanol-water partition coefficient. For the chlorinated ethenes a similar effect is probable, but less obvious. The toxicity of compounds with the same number of chlorine atoms is higher for ethane derivatives than for derivatives of ethene. The ED50 and ED25 values are compared with threshold values of physiological effects obtained after the application of 1,1,1-trichloroethane for 24 h to tobacco leaves. We presume that chlorinated hydrocarbons may cause stress even at lower concentrations than those suggested by the pollen test. Therefore the listed ED values (Table 1) should be considered as maximum tolerable values regarding phytotoxic effects in experimental investigations. For the important solvent 1,1,1-trichloroethane the ED25 value of phytotoxicity is lower than 4 mg/L; according to literature the concentration supposedly having no effect on man is 1.9 - 5.2 mg/L.

Source: Abstract


The effects of chlorine and pH on the bactericidal activity of electrolyzed (EO) water were examined against Escherichia coli O157:H7 and Listeria monocytogenes. The residual chlorine concentration of EO water ranged from 0.1 to 5.0 mg/l, and the pH effect was examined at pH 3.0, 5.0, and 7.0. The bactericidal activity of EO water increased with residual chlorine concentration for both pathogens, and complete inactivation was achieved at residual chlorine levels equal to or higher than 1.0 mg/l. The results showed that both pathogens are very sensitive to chlorine, and residual chlorine level of EO water should be maintained at 1.0 mg/l or higher for practical applications. For each residual chlorine level, bactericidal activity of EO water increased with decreasing pH for both pathogens. However, with sufficient residual chlorine (greater than 2 mg/l), EO water can be applied in a pH range between 2.6 (original pH of EO water) and 7.0 while still achieving complete inactivation of E. coli O157:H7 and L. monocytogenes. Source


Acidic electrolyzed water (acidic EW), which is prepared by the electrolysis of an aqueous NaCl solution, has recently become of great importance for disinfection in a variety of fields, including medicine, the food industry and agriculture. In a previous paper we showed
that: 1) acidic EW is a mixture of hypochlorite ion, hypochlorous acid and chlorine, depending upon the pH; 2) hypochlorous acid is primarily responsible for disinfection in the case of Escherichia coli K12 and Bacillus subtilis PCI219, both in clean culture media. In practice, however, the use of acidic EW is in many cases severely hampered due to the presence of a variety of non-selective reducing agents. In view of the salient nature of acidic EW, it is therefore strongly urged to establish an optimum way to use acidic EW in a variety of systems. The present paper is the first report on our attempt along this line in order to characterize The nature of the chemical changes that the bactericidal activity of the acidic EW deteriorates in the presence of organic materials, which include amino acids and proteins.

Abstract


The use of water flotation tanks during apple packing increases the risk of contamination of apples by spores of *Penicillium expansum*, which may accumulate in the recirculating water. Routine addition of sanitizers to the water may prevent such contamination. Sodium hypochlorite (NaOCl), chlorine dioxide (ClO2), and electrolyzed oxidizing (EO) water have varied activity against spores of *P. expansum*, and their effectiveness could be enhanced by surfactants. The objective of this study was to determine the ability of three nonionic surfactants, polyoxyethylene sorbitan monoleate (Twee 80), polyoxyethylene sorbitan monolaurate (Twee 20), and sorbitan monolaurate (Span 20), to enhance the efficacy of NaOCl, ClO2, and EO water against spores of *P. expansum* in aqueous suspension at various temperatures and pH conditions. The efficacy of NaOCl solutions was enhanced by the addition of surfactants at both pH 6.3 and pH 8 (up to 5 log CFU reduction). EO water and ClO2 were effective against P. expansum spores (up to 5 log CFU and 4 log CFU reduction, respectively), but addition of surfactants was not beneficial. All solutions were less effective at 4 degrees C compared to 24 degrees C irrespective of the presence of surfactants. Nonionic surfactants could potentially be used with NaOCl to improve control of P. expansum in flotation tanks, but the efficacy of such formulations should be validated under apple packing conditions.

Source: Abstract


Electrolyzed strong and weak acid waters have been widely used for sterilization in clinical dentistry because of their excellent bactericidal activities. Electrolyzed neutral water was recently developed with a new concept of long-term good durability in addition to the excellent bactericidal activity similar to acid waters. The present study, evaluated the storage life of this water compared with the acid waters in terms of the changes in pH, oxidation-reduction potential (ORP), residual chlorine and bactericidal activity under several conditions using Staphylococcus aureus 209P. The strong acid water showed a rapid deterioration of its bactericidal activity. The weak acid and neutral waters exhibited excellent durability. Although all the bacteria were annihilated by the contact with the waters even stored for 40 days in the uncapped bottle, the neutral water was superior in further long-term duration.

Source: Abstract


Electrolyzed products of sodium chloride solution were examined for their disinfection potential against hepatitis B virus (HBV) and human immunodeficiency virus (HIV) in vitro. Electrolysis of 0.05% NaCl in tap water was carried out for 45 min at room temperature using a 3 A electric current in separate wells installed with positive and negative electrodes. The electrolyzed products were obtained from the positive well. The oxidation reduction potential (ORP), pH and free chlorine content of the product were 1053 mV, pH 2.34 and 4.20 ppm, respectively. The products modified the antigenicity of the surface protein of HBV as well as the infectivity of HIV in time- and concentration-dependent manner. Although the inactivating potential was decreased by the addition of contaminating protein, recycling of the product or continuous addition of fresh product may restore the complete disinfection against bloodborne pathogens.

Source: Abstract


Electrolyzed Water (Acidic Electrolyzed Water, Alkaline Electrolyzed Water) has recently attracted the interest of researchers in various fields such as medicine, agriculture and food processing. In this study, we investigated the preservability of Electrolyzed Water produced in a two-cell batch-type apparatus. It was found that Acidic Electrolyzed Water could be preserved for one year under shaded and sealed conditions. However, Acidic Electrolyzed Water became inert after three days when exposed to light, although pH remained stable for one year. It was found out that the quality of Alkaline Electrolyzed Water changes easily regardless of preservation conditions.

Source: Abstract


Electrolyzed water (EW) has attracted much recent attention as a high-performance, new technology for potential use in the food industry. However, this is the first review which examines the potential of the antimicrobial effect of electrolyzed water solutions in many different food models such as vegetable, fruits, meat, poultry, fish, and other products. Production, theoretical of the chemical reactions in the production of EW, theories of disinfectant effect of EW and advantage of using EW would be reviewed. The purpose of this review is to introduce simple information about the use of this new technology in the field of food disinfection, for both readers and food industry.

Source: Abstract


Acid adaptation of Salmonella typhimurium at a pH of 5.0 to 5.8 for one to two cell doublings resulted in marked sensitization of the pathogen to halogen-based sanitizers including chlorine (hypochlorous acid) and iodine. Acid-adapted S. typhimurium was more resistant
to an anionic acid sanitizer than was its nonadapated counterpart. A nonselective plating medium of tryptose phosphate agar plus 1% pyruvate was used throughout the study to help recover chemically stressed cells. Mechanisms of HOCl-mediated inactivation of acid-adapted and nonadapted salmonellae were investigated. Hypochlorous acid oxidized a higher percentage of cell surface sulfhydryl groups in acid-adapted cells than in nonadapted cells, and sulfhydryl oxidation was correlated with cell inactivation. HOCl caused severe metabolic disruptions in acid-adapted and nonadapted S. typhimurium, such as respiratory loss and inability to restore the adenylate energy charge from a nutrient-starved state. Sensitization of S. typhimurium to hypochlorous acid by acid adaptation also involved increased permeability of the cell surface because nonadapted cells treated with EDTA became sensitized. The results of this study establish that acid-adapted S. typhimurium cells are highly sensitized to HOCl oxidation and that inactivation by HOCl involves changes in membrane permeability, inability to maintain or restore energy charge, and probably oxidation of essential cellular components. This study provides a basis for improved practical technologies to inactivate Salmonella and implies that acid pretreatment of food plant environments may increase the efficacy of halogen sanitizers.

Source: Abstract


The objective of this study was to determine the efficacy of acidic electrolyzed (AEO) water produced from different generators and principles in inactivating Escherichia coli O157:H7. AEO and NEO water were produced using EAU, Hoshizaki, Purester, and Radical Waters generators and used to treat E. coli O157:H7 for up to 5 min before and after storage for 48 h at 22°C. The properties of respective AEO and NEO water produced from different generators were similar, except for Purester. The efficacy of AEO water from different generators in inactivating E. coli O157:H7 was not significantly different. AEO water inactivated more E. coli O157:H7 viable cells than NEO. The most effective NEO water for inactivation of E. coli O157:H7 was NEO water from EAU generator, followed by NEO water from Radical Waters and Purester. The free chlorine levels and antimicrobial activity of AEO water significantly decreased after storage. The properties of NEO water were relatively stable and their ability in inactivating E. coli O157:H7 did not change significantly after storage for 48 h in open bottles, except for NEO water from Purester. The results of this study can be used to determine the choice of generators and type of electrolyzed water to be produced, depending on the resources, purpose and need. Source: pdf


Inactivation by hypochlorite of Listeria monocytogenes cells adherent to stainless steel was determined. Adherent cell populations were prepared by incubating stainless steel slides with a 24 h culture of L. monocytogenes for 4 h at 21°C. Adherent microcolonies were prepared by growing L. monocytogenes on stainless steel slides submerged in a 1:15 dilution of tryptic soy broth at 21°C. The slides were then rinsed and transferred to fresh sterile broth every 2 d with a total incubation time of 8 d. Although the 4 h and 8 d adherent populations were at similar levels, 8 d adherent cells were over 100 times more resistant than the 4 h adherent cell population when exposed to 200 ppm hypochlorite for 30 s. When stainless steel slides containing adherent cells were heated at 72°C both adherent cell populations were inactivated after 1 min. Detectable numbers of L. monocytogenes remained on stainless steel slides after treatment at 65°C for 3 min when adherent 8 d cells were tested but not when adherent 4 h cells were used.

Source: Abstract


The chlorine loss of electrolyzed oxidizing (EO) water was examined during storage under different light, agitation, and packaging conditions. The chlorine loss of pH-adjusted EO water was also examined. Under open conditions, the chlorine loss through evaporation followed first-order kinetics. The rate of chlorine loss was increased about 5-fold with agitation, but it was not significantly affected by diffused light. Under closed conditions, the chlorine loss did not follow first-order kinetics, because the primary mechanism of chlorine loss may be self-decomposition of chlorine species rather than chlorine evaporation. The effect of diffused light was more significant compared to agitation after two months of storage under closed conditions. The chlorine loss of EO water and commercial chlorinated water decreased dramatically with the increase of pH from the acidic (pH 2.5) to the alkaline (pH 9.0) region.

Source: Abstract pdf


To identify the primary component responsible in electrolyzed oxidizing (EO) water for inactivation, this study determined the concentrations of hypochlorous acid (HOCl) and hypochlorite ions (OCI-) and related those concentrations to the microbical activity of the water. The ultraviolet absorption spectra were used to determine the concentrations of HOCl and OCI- in EO water and the chemical equilibrium of these species with change in pH and amperage. EO water generated at higher amperage contained a higher chlorine concentration. The maximum concentration of HOCl was observed around pH 4 where the maximum log reduction (2.3 log10 CFU/ml) of Bacillus cereus F4317/73 vegetative cells also occurred. The high correlation (r = 0.95) between HOCl concentrations and bactericidal effectiveness of EO water supports HOCl’s role as the primary inactivation agent. Caution should be taken with standard titrimetric methods for measurement of chlorine as they cannot differentiate the levels of HOCl present in EO water of varying pHs.

Source: Abstract


Electrolyzed products of a sodium chloride solution contain free residual chlorine and have been proved to be effective for disinfection. Electrolyzed strong acid water containing a low sodium chloride concentration (ESW-L) is prepared by the electrolysis of a solution containing a low sodium chloride concentration (0.1% or less). Although ESW-L has been confirmed to be an effective disinfectant, disinfective efficacy against dried HIV-1 and a target of ESW-L against HIV-1 have not been clarified. In this study, we attempted to
demonstrate the efficacy of ESW-L against dried HIV-1 which relatively resists disinfection and to analyze disinfection target. We demonstrated that ESW-L inactivated the infectivity of dried HIV-1. In the analysis of the mechanism of disinfection, although the HIV-1 structural protein, p24 within the virus particle, was not inactivated by ESW-L, the enzymatic activity of reverse transcriptase (RT) and genomic RNA within the particle, however, were inactivated after the treatment with ESW-L. These findings suggest that the enzymatic activity of RT and genomic RNA are the target of ESW-L.

Source: Abstract pdf


Electrolyzed strong acid water (ESW) containing free chlorine at various concentrations is becoming to be available in clinical settings as a disinfectant. ESW is prepared by electrolysis of a NaCl solution, and has a corrosive activity against medical instruments. Although lower concentrations of NaCl and free chlorine are desired to eliminate corrosion, the germicidal effect of ESW with low NaCl and free-chlorine concentrations (ESW-L) has not been fully clarified. In this study, we demonstrated that ESW-L possesses bactericidal activity against Mycobacteria and spores of Bacillus subtilis. The effect was slightly weaker than that of ESW containing higher NaCl and free-chlorine concentrations (ESW-H), but acceptable as a disinfectant. To clarify the mechanism of the bactericidal activity, we investigated ESW-L-treated Pseudomonas aeruginosa by transmission electron microscopy, a bacterial enzyme assay and restriction fragment length polymorphism pattern (RFLP) assay. Since the bacterium, whose growth was completely inhibited by ESW-L, revealed the inactivation of cytoplasmic enzyme, blebs and breaks in its outer membrane and remained complete RFLP of DNA, damage of the outer membrane and inactivation of cytoplasmic enzyme are the important determinants of the bactericidal activity.

Source: pdf

7.1.29 Investigation of the presence of OH radicals in electrolyzed NaCl solution by electron spin resonance spectroscopy, Stan SD, Woods JS, Daeschel MA. Department of Food Science and Technology, Oregon State University, 100 Wiegand Hall, Corvallis, Oregon 97331, USA.

In the anode side of a two-chamber electrolyzer, electrolysis of a NaCl solution generates acidic electrolyzed oxidizing (EO) water, which exhibits bactericidal effects against a large number of pathogens. This study was undertaken to investigate whether OH radical species are present in EO water or are formed when EO water reacts with iron ions. Electron spin resonance spectroscopy (ESR) coupled with the spin trapping technique was used for the detection of free radicals. Samples of EO water were collected at 0.5, 1, 2, 3, and 5 min of electrolysis and immediately mixed with the spin trapping agent 5,5-dimethyl-1-pyrroline-N-oxide (DMPO). The 5,5-dimethyl-2-hydroxypyrrrolidine-N-oxyl (DMPO- OH) spin adduct, characteristic of OH radicals, was not observed. Starting with 2-min electrolysis, a seven-line spectrum characteristic of 5,5-dimethyl-2-pyrroldone-N-oxyl (DMPOX) was formed. The reactions of EO water with Fe3+ and Fe2+ in the presence of DMPO yielded the spin adduct DMPO-OH. However, the addition of OH radical scavengers (ethanol and methanol) did not generate the characteristic DMPO-alkyl spin adducts. This indicated that the DMPO-OH spectrum was due to a nucleophilic addition of water to DMPO and not to trapping of OH radicals.

Source: Abstract