APPLICATION OF ELECTROLYZED WATER IN THE FOOD INDUSTRY

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Abstract

Electrolyzed water is a novel disinfectant and cleaner that has been widely utilized in the food sector for several years to ensure that surfaces are sterilized, and that food is safe. It is produced by the electrolysis of a dilute salt solution, and the reaction products include sodium hydroxide (NaOH) and hypochlorous acid. In comparison to conventional cleaning agents, electrolyzed water is economical and eco-friendly, easy to use, and strongly effective. Electrolyzed water is also used in its acidic form, but it is non-corrosive to the human epithelium and other organic matter. The electrolyzed water can be utilized in a diverse range of foods; thus, it is an appropriate choice for synergistic microbial control in the food industry to ensure food safety and quality without damaging the organoleptic parameters of the food.

Objective

The present review highlights the latest information on the factors responsible for food spoilage and the antimicrobial potential of electrolyzed water in fresh or processed plant and animal products.

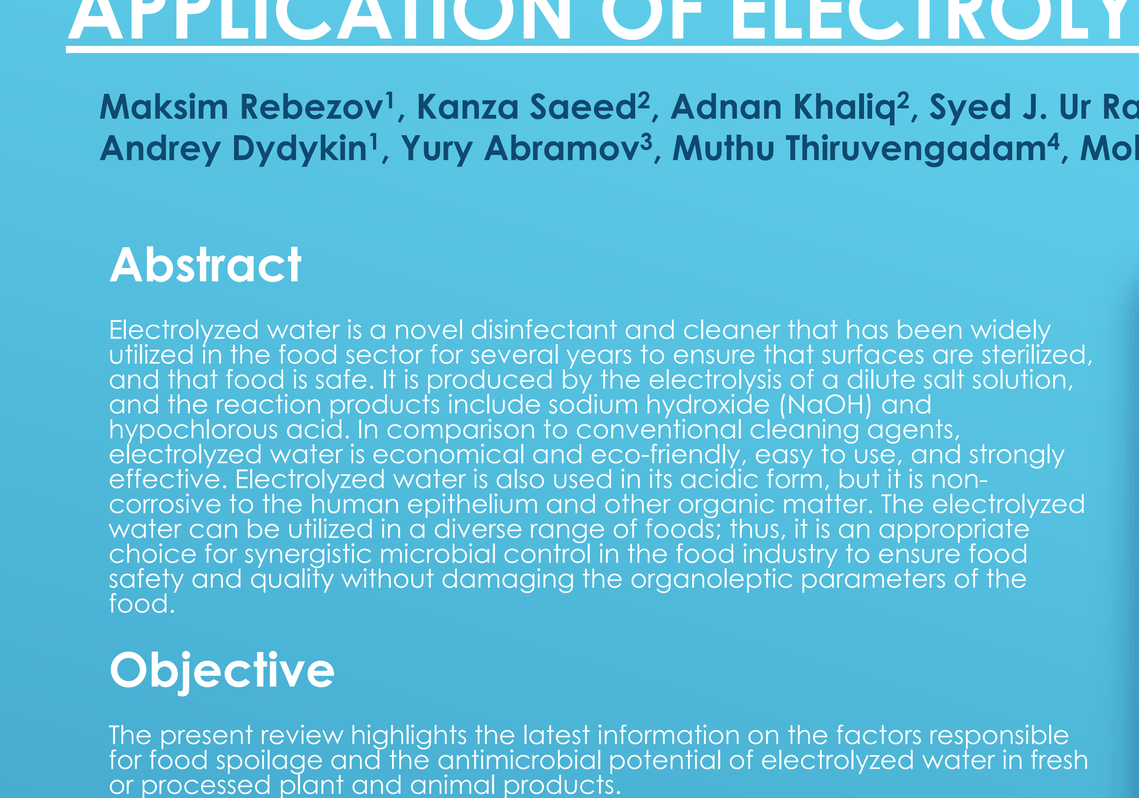

Figure 1. Schematic diagram of electrolyzed water manufacturing

Electrolyzed water is not only inexpensive but is also far more effective than conventional cleaning agents. Electrolyzed water kills pathogenic microorganisms and protects the environment from the adverse impacts of hazardous chemical disinfectants. ***Figure 1*** shows a schematic diagram of electrolyzed water manufacturing.

This process creates cheaper, safer, and more effective products compared to dangerous synthetic chemical preservatives such as acetic acid, sodium hypochlorite, and glutaraldehyde.

To enhance food safety and product quality, intrinsic and extrinsic factors are both naturally and artificially modulated. The adjustments made to these factors/conditions minimize and/or prevent the growth and establishment of microbial flora, which in turn escalates the shelf-life of food. ***Figure 2*** summarizes the factors responsible for food spoilage.

EW has antimicrobial properties against food pathogenic microorganisms attached to cutting boards, kitchen surfaces, poultry and meat carcasses, cell suspensions, and vegetables. Some researchers consider the chlorine present in EW as the major antimicrobial, while others regard ORP as the major factor responsible. Other factors affecting the sanitization efficiency of EW include the water flow rate, current, salt concentration, electrolytes, hardness of the water, water temperature, and electrode material.

The antimicrobial efficacy of EW is affected by the water's temperature and hardness level. In this regard, the microbial efficacy of SAEW improved with the increased temperature of the water . The antimicrobial efficacy of AEW was evaluated against *Listeria monocytogenes* and *Salmonella typhimurium* at 4°C and 25°C. The results showed the maximum log reduction of more than 8 CFU/mL at 25°C. On the contrary, other results showed that preheated SAEW presented a greater log reduction against *Listeria monocytogenes* and *E. coli* O157:H7 compared to heated SAEW. The phenomenon has been attributed to the partial loss of ACC while heating.

It has been shown that by increasing the hardness level of water, both the free chlorine and the ORP increase, and the decrease in the pH results in the destruction of pathogenic microbes. The increase in water hardness may increase the electrolyte concentration and the electric current or conductivity of the solution and resultantly increase the chlorine production. The factors that affect the properties of EW include voltage, salt concentration, and electrolyte flow rate. It has been concluded that these factors influence the overall attributes of EW, including the sanitizing efficacy. There is a need to develop proper standard operating procedures for the manipulation of EW, and they must be implemented to obtain more benefits from the sanitizing properties of EW.

Table 1 shows food the safety applications of different types of electrolyzed water in the food industry.

EW water can be utilized for the disinfection of food processing plants. It was revealed that electrically oxidized water is an efficient method for removing foodborne pathogens from cutting boards. EW water (pH – 2.53; electrically conductivity – 1178 mV; available Cl – 53.0 mg/L) can also cause a reduction in Enterobacter and golden grapes on the surface of the glass, steel, glazed plates, stainless steel, non-woven plates and glass porcelain surfaces. Soaking the culture at different contact places in electrically oxidized water for 5 min under stirring 50 rpm can reduce the population of *aerobic E. coli* and *Staphylococcus* on a test surface to <1.0 CFU/cm2.

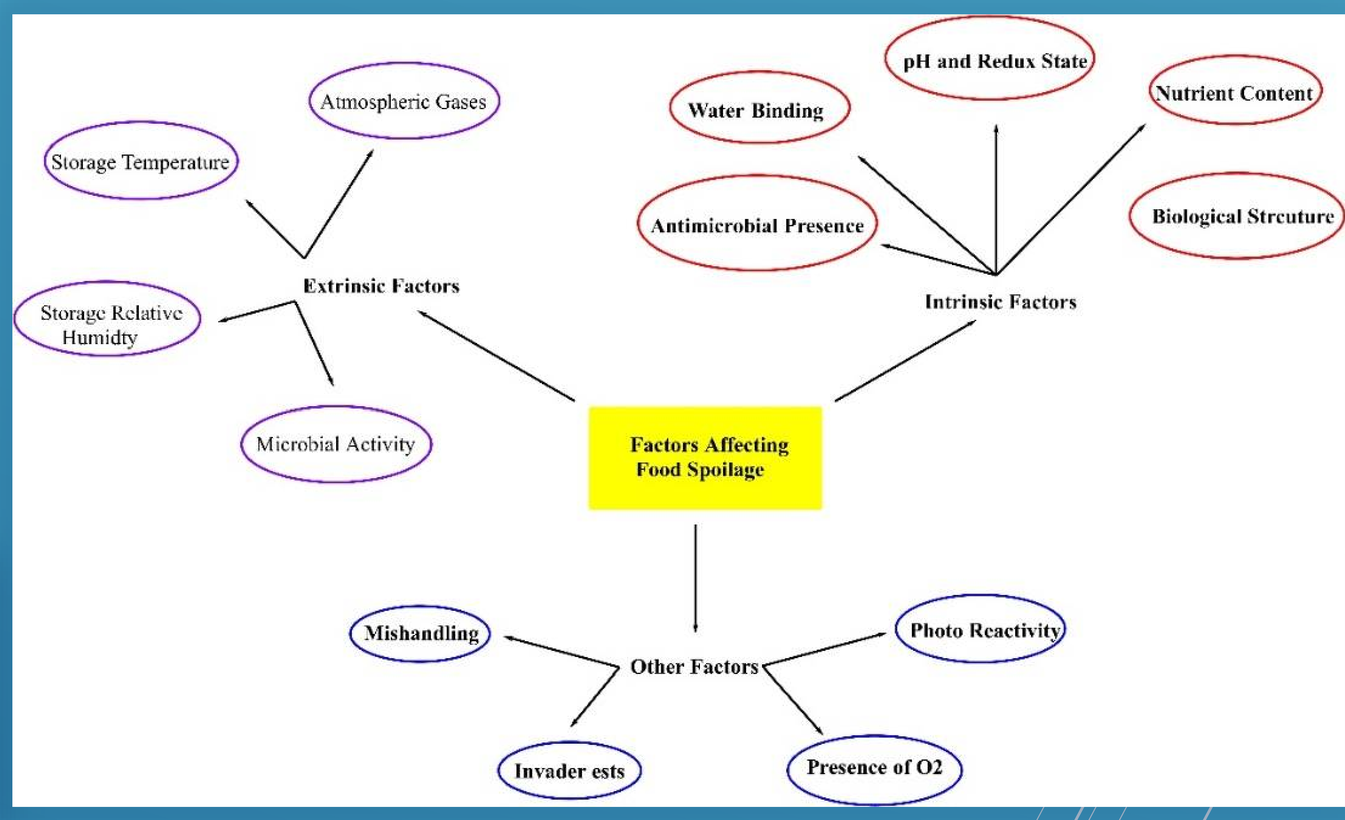

Figure 2. Main factors responsible for food spoilage

EW Generating Machine	Salt/Acid Used as Substrate	pH	Reported Food Safety Application	Target Pathogen
NEW	NaCl (1.0%)	8.6	Lettuce, corn salad, shredded carrots, freshly cut iceberg lettuce	*Salmonella*, *Escherichia coli*
AEW	NaCl (0.1–0.2%)	2.5	Alfalfa seeds and sprouts, tomatoes	*E. coli* O157:H7, *Listeria monocytogenes*
NEW	NaCl (25%)	8.27	Plastic and wood cutting boards	*Staphylococcus aureus*, *Listeria monocytogene*, *Pseudomonas*
SAEW	NaCl (0.1%)	5.9	Pure culture	*Vibrio vulnificus*
SAEW	HCl (2%)	5.8	Pure culture	*Escherichia coli*, *Salmonella*, *S. aureus*
SALcEW	NaCl (0.9%)	6.2–6.3	Freshly cut spinach	Total bacteria, yeast, molds, *E. coli* O157:H7, *Listeria monocytogenes*
SAEW	NaCl (0.6%) and HCl (0.15%)	6–6.5	Pure culture, Lettuce, pork	Total bacteria, *Listeria monocytogenes*

NEW: Neutral electrolyzed water; AEW: Acidic electrolyzed water; SALcEW: Slightly acidic low concentration electrolyzed water; SAEW: Slightly acidic electrolyzed water.

Table 1. Food safety applications of different types of electrolyzed water

Conclusions

1. EW, an environment-friendly sanitizer, manifests strong antimicrobial properties in various industries, including the food, pharmaceutical, and agricultural industries.
2. Through the development of novel EW such as Strongly Alkaline Electrolyzed Water (StALEW) and Slightly Acidic Electrolyzed Water (SAEW), many of the issues related to corrosiveness that were posed to StAEW and AEW have been resolved. The properties of EW depend on various parameters, such as the temperature of the water, ORP, ACC, electrolyte type, storage conditions, salt concentration, and water flow. The effect of water hardness on sanitizing efficiency needs to be researched further. EW can be utilized in a diverse range of food products and is thereby an appropriate choice for synergistic microbial control in the food industry to ensure food safety and quality without damaging the organoleptic parameters of the food. However, standard operating procedures (SOPs) and proper legislation are needed for direct contact with high porosity foods and equipment surfaces for microbial inactivation. Therefore, through proper research, a dynamic and advanced approach to ensuring sustainable food safety can be developed to overcome all the limitations.

References

List of sources used is presented at the link: **https://www.mdpi.com/2076-3417/12/13/6639**

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