

Electrolyzed Water in Poultry Production and Processing

*Aditya Adgaonkar

ICAR- Indian Veterinary Research Institute, Izzatnagar, Bareilly, U.P., India

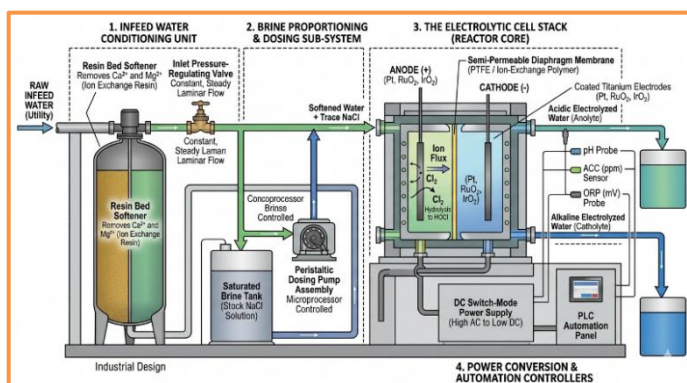
*Corresponding Author's email: adagaonkaraditya@gmail.com

Food safety has escalated into a severe global public health crisis, driven by rising poultry consumption with global per capita chicken intake hitting a historic high of 14.86 kilograms. Because nutrient-rich poultry provides an ideal environment for rapid bacterial growth, a minor breakdown in sanitation can trigger massive outbreaks. Annually, foodborne illnesses strike 48 million people in the United States (resulting in 128,000 hospitalizations and 3,000 deaths), cause over 120,000 *Campylobacter* cases in the EU, and lead to nearly 150 million illnesses and 175,000 deaths in the South-East Asia Region. The primary threat occurs during automated poultry processing stages-such as scalding, evisceration, and cooling where shared machinery drives severe cross-contamination. Critical biological hazards include *Salmonella enteritidis*, which infects egg interiors before shell formation; *Campylobacter jejuni*, which transfers from bird digestive tracts; and *Listeria monocytogenes*, which thrives in cold, damp processing environments. While traditional chemical disinfectants like hypochlorite and ozone work, their high operational costs, toxicity to workers, and corrosive nature have forced a shift toward advanced, non-thermal technologies. Among these innovations, electrolyzed water stands out as an elite, cost-effective, and eco-friendly sanitizing solution that neutralizes these lethal pathogens without altering food properties.

Electrolysed Water: The Electric Revolution in Sanitation

Electrolysed water (EW): is a highly efficient sanitizing solution created by passing a dilute salt water solution through an electrical chamber. This electrochemical process generates powerful antimicrobial compounds mainly hypochlorous acid and hypochlorite ions-alongside a high oxidation-reduction potential that instantly destroys bacteria, viruses, and fungi on contact. Unlike harsh traditional chemical concentrates, it acts as a deeply active but unstable biological shield that quickly reverts back into ordinary water and salt, making it completely safe for the environment.

The Electrochemical Production Mechanism: Electrolysed water is produced using a direct current (9-10 volts, 8-10 amperes) to separate a salt solution into two electrical poles. At the negative cathode, reduction occurs as positive ions (hydrogen and sodium) gain electrons to form hydrogen gas and sodium hydroxide. Meanwhile, at the positive anode, oxidation takes place as negative ions (chloride and hydroxide) lose electrons to generate oxygen gas, chlorine gas, hypochlorite ions, hypochlorous acid, and hydrochloric acid. Depending on whether these two streams are kept separate or allowed to mix, different functional variations of sanitizing water are created.



The Four Chemical Variations and Their Industrial Roles

- Acidic (AEW): pH 2-3.5, high ORP (>1000 mV), 10-90 ppm chlorine. Powerful antibacterial agent.
- Alkaline (ALEW): pH 10-13, negative ORP (-800 to -900 mV). Acts like a detergent to clean organic waste.
- Neutral (NEW): pH 7-8, ORP 750-900 mV. Long shelf life, low corrosion, kills pathogens.
- Slightly Acidic (SAEW): pH 5.0-6.5, ORP 800-900 mV. Uses hypochlorous acid for elite disinfection.

Commercial Equipment and Chamber Architecture

Electrolyzed water machines are commercialized by prominent Japanese and US manufacturers like Aquaox, Hoshizaki Electric, Envirolite, MIOX, and AMANO. These generators are divided into two main categories based on their internal architecture: dual-cell systems and single-cell systems. Dual-cell machines utilize a separating diaphragm to simultaneously harvest isolated streams of acidic and alkaline water at opposite poles. In contrast, single-cell machines lack a membrane entirely, allowing ions to mix directly inside the chamber to smoothly produce neutral or slightly acidic electrolyzed water in a single continuous stream.

Factors Influencing Sanitizing Efficacy and Stability

The basic sanitizing properties and overall efficacy of the finished electrolyzed water are heavily dependent on several critical electrolytic and environmental factors. The available chlorine concentration (ACC), pH, and ORP directly dictate how quickly pathogens are neutralized. The fundamental fractions of chlorine species in the solution are determined by pH; hypochlorous acid is highly stable and active between pH 5.0 and 6.5, but shifts into weaker hypochlorite ions at alkaline values, or dissociates into volatile chlorine gas at extremely low pH values. Furthermore, operational parameters such as the electrical current, water flow rate, and initial salt concentration drastically alter the output. Increasing the electrical current raises the ACC and ORP, whereas a higher water flow rate reduces the time the solution spends in contact with the electrodes, leading to lower overall ACC and ORP values. Additionally, water hardness and pre-heating methods can enhance conductivity and increase ACC levels, while open, bright storage environments lead to rapid chlorine loss through evaporation and self-decomposition.

Application in the Poultry Sector: From Farm Biosecurity to Post-Harvest Processing

Farm-Level Biosecurity and Environmental Sanitation: While electrolyzed water finds diverse uses across multiple agricultural domains, its implementation within the poultry sector offers profound benefits, serving as a critical intervention from the early stages of live bird management through final processing. In modern broiler and layer industries, reducing foodborne infections begins at the farm level. The primary vector for enteric pathogens on livestock farms is animal manure, which easily contaminates housing structures and surrounding environments. By incorporating automated spraying and misting systems that utilize membrane-less acidic electrolyzed water or slightly acidic electrolyzed water, producers can continuously sanitize the air and surfaces within crowded layer and swine barns. Studies show that spraying MLAEW reduces the level of total airborne bacteria by up to 70% in cage hen houses, while flush treatments with SAEW decrease the survival rates of environmental Salmonella and E. coli by 21% and 16% respectively, effectively breaking the transmission cycle before the birds ever leave the facility.

Early Disease Intervention in Commercial Hatcheries: Moving backwards in the production chain, the commercial hatchery represents one of the most critical environments for early disease intervention within a vertically integrated poultry company. The presence of Salmonella in the hatchery is directly associated with widespread contamination among

subsequent broiler flocks, as dangerous microorganisms routinely penetrate vulnerable eggshell pores or micro-cracks. This penetration kills developing embryos, reduces overall hatchability, and compromises chick quality post-hatching. Spraying hatching eggs with acidic electrolyzed water or slightly acidic electrolyzed water significantly drops the total aerobic bacterial counts on the shell surface without damaging the delicate outer cuticle structure, normal embryonic development, or hatchability. Remarkably, field data reveals that broiler mortality during the first two weeks of the production period is significantly reduced in chicks hatched from eggs sanitized with electrolyzed water, establishing a clean biological foundation for the entire flock.

Drinking Water Line Decontamination and Antibiotic Reduction: The physical shade, sanitation, and structural surfaces of the animal housing are further secured through specialized washing interventions. Beyond structural disinfection, electrolyzed water is transforming flock health from the inside out through drinking water lines. Maintaining clean drinking water lines in massive poultry houses has historically required continuous antibiotic management to prevent biofilm build-up and bacterial proliferation. Integrating low-concentration electrolyzed water as a permanent, non-toxic supplementary water treatment purifies the flock's water supply without causing any negative effects on bird health or physiological performance. This simple operational upgrade dramatically reduces the industry's reliance on therapeutic antibiotics, perfectly aligning with modern global regulatory requirements regarding the reduction of antibiotic substances in food production.

Post-Harvest Processing and Carcass Decontamination: Once the poultry reaches the automated slaughterhouse or abattoir, the risk of rapid cross-contamination peaks during high-speed commercial feather removal, evisceration, and carcass washing. Inadequately cleaned processing equipment easily transfers pathogens onto clean carcass surfaces, making robust sanitizers an absolute necessity. Integrating automated electrolyzed water interventions into post-harvest processing lines acts as an elite biological barrier. Submerging commercial broiler carcasses in an acidic electrolyzed water bath at 4°C for 45 minutes, or utilizing a combined AEW pre-wash spray followed by an AEW submersion, reduces *Salmonella typhimurium* contamination by an impressive 2.1 log reduction. Furthermore, extensive trials demonstrate that spray-washing carcasses with slightly acidic electrolyzed water yields rapid reductions in total aerobic bacteria, *E. coli*, *Campylobacter*, and *Salmonella*. Extending the automated washing time from 5 to 10 seconds maximizes these microbiological reductions, successfully neutralizing active pathogens on meat surfaces and protecting consumers from the risk of foodborne illness.

Advantages, Disadvantages, Challenges, and Future Horizons

Category	Advantages	Disadvantages
Eco & Food Safety	Zero residue & eco-friendly. Protects quality & freshness	High-acid types cause skin irritation.
Operations	On-demand on-site generation. No bulk shipping or storage.	Gas leaks require ventilation. Degrades fast in air/light/heat
Efficacy & Gear	Prevents resistance (non-selective).	Corrodes stainless steel. Fails in porous foods/gear.

Challenges

The widespread industrial adoption of electrolyzed water faces significant commercial challenges, primarily driven by high initial capital costs for specialized equipment, exhaust systems, and facility installation, which heavily limits its use among smaller processors. Additionally, the relatively slow production rate of the solution often struggles to meet the massive fluid volume demands required by high-speed commercial processing lines. Navigating diverse global regulatory frameworks remains the ultimate hurdle; while the United States, Japan, and Canada formally approve it for organic food sanitation, the European Union strictly bans its direct application on meat and fish products due to conservative protein-inactivation policies.

Conclusion

Electrolyzed water represents a profound leap forward in food safety, offering an elegant, sustainable solution to global foodborne pathogens by using a simple combination of salt, water, and electricity. It delivers elite antimicrobial power across the entire poultry sector from safeguarding hatcheries and purifying drinking water to blocking cross-contamination in high-speed slaughterhouses. As manufacturers refine single-cell designs to eliminate equipment corrosion and boost production volumes, the technology is becoming increasingly viable for global operations. Ultimately, unlocking its full potential will require harmonizing international regulatory approvals and investing in public awareness to secure consumer acceptance and drive industrial commercialization from farm to fork.