

# Effects of electrooxidation vs photoelectrooxidation on bentazone ecotoxicity for different supporting electrolytes

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## INTRODUCTION & AIM

**Bentazone (BTZ)**, a widely used herbicide detected in the **Albufera Natural Park**, is a persistent micropollutant with potential ecotoxic effects. Conventional wastewater treatments often fail to remove it completely. Directive (EU) 2024/3019 requires quaternary treatments achieving at least 80% micropollutant removal and toxicity reduction. Advanced oxidation processes, such as electrooxidation (EO) and photoelectrooxidation (PEO), are promising alternatives, though degradation may generate toxic by-products. Therefore, ecotoxicity was evaluated using *Lactuca sativa* root elongation to assess the environmental safety of treated effluents.

### AIMS

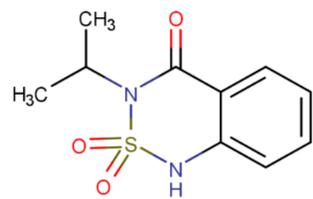


Figure 1. Structure of the BTZ molecule.

- Compare BTZ removal by EO and PEO.
- Assess electrolyte effects.
- Study the influence of current and irradiation on degradation/mineralization.
- Evaluate ecotoxicity via *Lactuca sativa* seeds.
- Identify conditions maximizing removal with minimal toxicity.

## METHOD

BTZ (100 mg L<sup>-1</sup>) was treated by EO and PEO in a 250 mL quartz reactor, using a ceramic Sb-SnO<sub>2</sub> anode coated with Bi<sub>2</sub>WO<sub>6</sub> photocatalyst and a stainless steel cathode. Experiments were conducted for 4 h at two current intensities (0.2 and 0.6 A), in the absence and presence of light (xenon lamp). Three supporting electrolytes were evaluated: 1.65 g L<sup>-1</sup> NaCl (Fig. 3a), 2 g L<sup>-1</sup> Na<sub>2</sub>SO<sub>4</sub> (Fig. 3b), and a mixture of 0.46 g L<sup>-1</sup> NaCl and 1.3 g L<sup>-1</sup> Na<sub>2</sub>SO<sub>4</sub> (Fig. 3c) simulating Albufera Lake conditions. Degradation was monitored by UV-Vis spectrophotometry (225 nm) and mineralization by total organic carbon (TOC) analysis. Ecotoxicity was assessed using *Lactuca sativa* seeds root elongation inhibition (5-day exposure).



Figure 2. EO reactor (left) and Petri dish with *Lactuca sativa* seeds (right).

## CONCLUSIONS

- PEO proved more effective than conventional EO for BTZ removal, achieving higher degradation, mineralization and ecotoxicity reduction.
- Performance depended on current intensity and electrolyte type, with the mixed NaCl-Na<sub>2</sub>SO<sub>4</sub> system at high current giving the best results.
- Optimal conditions enhanced contaminant removal while significantly lowering effluent toxicity.
- These results support PEO as an effective and sustainable quaternary treatment for micropolluted waters.

## RESULTS & DISCUSSION

Table 1. Degradation and mineralization degree of solutions containing BTZ and different supporting electrolytes

Supporting Electrolyte	Process	Applied Current (A)	Degradation (%)	Mineralization (%)
NaCl (1.65 g L <sup>-1</sup> )	Initial solution	-	-	-
	Electrooxidation	0.2	50.5	16.8
		0.6	85.1	57.2
	Photoelectrooxidation	0.2	83.4	31.7
		0.6	92.7	58.2
Na <sub>2</sub> SO <sub>4</sub> (2 g L <sup>-1</sup> )	Initial solution	-	-	-
	Electrooxidation	0.2	47.5	25.3
		0.6	74.6	48.5
	Photoelectrooxidation	0.2	52.1	23.6
		0.6	78.6	63.9
NaCl (0.46 g L <sup>-1</sup> ) + Na <sub>2</sub> SO <sub>4</sub> (2 g L <sup>-1</sup> )	Initial solution	-	-	-
	Electrooxidation	0.2	42.2	19.9
		0.6	85.1	54.5
	Photoelectrooxidation	0.2	68.0	33.4
		0.6	90.9	62.4

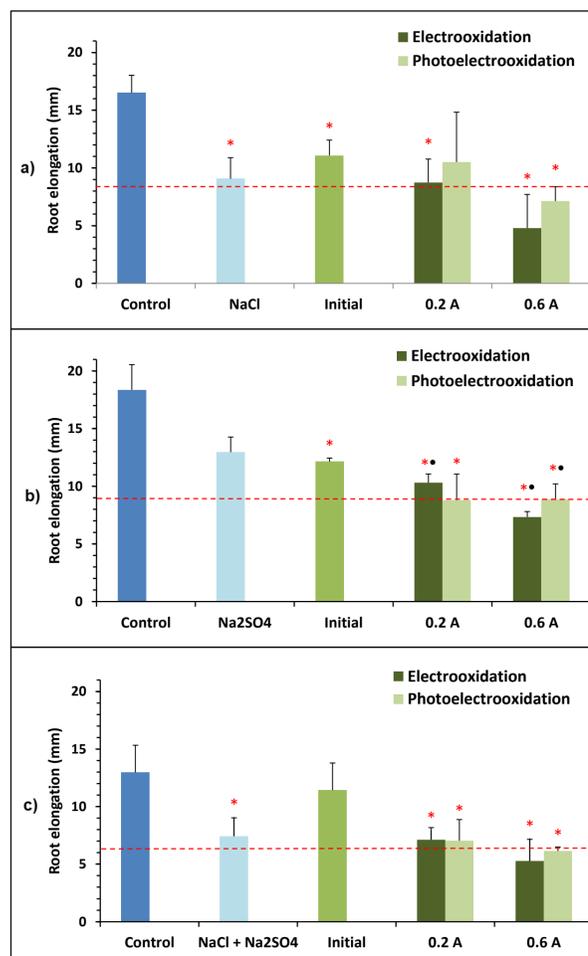


Figure 3. Toxicity towards *Lactuca sativa* of solutions containing BTZ and different supporting electrolytes

The synergistic interaction of oxidative pathways intensified during PEO at higher current and with a mixed supporting electrolyte. Chlorides and sulfates promote the simultaneous generation of highly reactive oxidizing species (chlorine species, sulfate-derived and hydroxyl radicals), while light irradiation enhances photocatalytic reactions that convert intermediates into less toxic or fully mineralized products. Consequently, contaminant removal increases and the ecotoxicity of the treated effluent decreases.

The mixed NaCl-Na<sub>2</sub>SO<sub>4</sub> electrolyte showed intermediate degradation and mineralization compared with pure electrolytes, but at 0.6 A its performance approached the highest values obtained with NaCl. Under these conditions, PEO achieved 90.9% degradation and 62.4% mineralization, surpassing the 80% removal requirement established by Directive (EU) 2024/3019.

Ecotoxicity towards *Lactuca sativa* increases after treatment, although to a lesser extent when light was applied. The combination of PEO at 0.6 A using the mixed electrolyte provided the lowest final toxicity together with the highest removal efficiency.