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Feasibility of Using Irradiation to Degrade a Toxic Dye Compound

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Crystal Violet (CV), is widely used for dyeing cotton, silk and paper. It has carcinogenic and mutagenic effects other than antimicrobial properties. The toxicity of this wastewater represents a great risk to the ecosystem and need to be treated before being discharged into the environment. However, the complex aromatic molecular structures of CV make them more stable and more problematic to degrade.
Therefore, the removal of this synthetic dye is of great concern because of the difficulty in treating such effluent by conventional methods.
In this study gamma radiation was investigated as a method for removing CV from water. Absorbance, concentration, toxicity in eukaryotic cells and bacteria's were analyzed.
The CV solution (300 mg/l) in glass bottles were irradiated in a Cobalt-60 gamma-radiation facility. Absorbance (1/10 dilution) and concentration were measured in a UV-vis spectrometer. Cytotoxicity was tested in Vero Cells after 24 h of treatment with different concentration of CV solution irradiated. Cellular viability was determined with CV staining assays and absorbance analysis at 570 nm. Cytotoxic concentration 50% (CC50) was calculated comparing treated cells with cellular control. Antimicrobial susceptibility were analyzed using the NCCLS guidelines for the microdilution method and minimum inhibitory concentration (MIC) was defined.
The absorbed doses of CV solution were 1.1, 2.2, 3.1, 4.5 and 5.2 kGy, the absorption spectra showed very small shift of the major peaks at about 300 nm and 580 nm but a reduction in the height as the dose increase, indicating that the concentration of CV is reduced. However, an small peak appears in the irradiated solution at 359 nm, indicating the possible formation of an intermediate metabolite 4,4'-bis(dimethylamino) benzophenone, as was reported by other authors. The absorbed dose strongly affects the degradation of CV in water, at 1 kGy 66% was still remaining, and 20% with 5.2 kGy (Fig. 1).
The cell viability results from CV 0 kGy demonstrated the severe inhibitory effects by these chemicals; the CC50 was 8.8 mg/l. In contrast, the treatment of the solution with the incremental doses of gamma radiation reduced the toxicity. The results showed that with 1.1 kGy the CC50 was 85.6 mg/l and 109 mg/l for the solution treated with 5.2 kGy. Antimicrobial activity of the CV solution showed a reduction in a dose-based effect in all the microorganisms tested. *Staphylococcus aureus* MIC increase from 1.5 mg/l to 37.5 mg/l for the solutions 0 kGy and 5.2 KGy. Similar results were obtained with *Bacillus cereus* (6.25 to 100 mg/l) and *Escherichia coli* (50 a >150 mg/l).
This study provided both, a reference for radiation degradation of CV without producing undesirable intermediate metabolites and an alternative treatment processes for dye wastewater.

Country/Organization invited to participate

Argentina

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