Electron Beam Decomposition of Losartan and Methocarbamol Two Emerging Pollutants from Aqueous Solutions

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Abstract

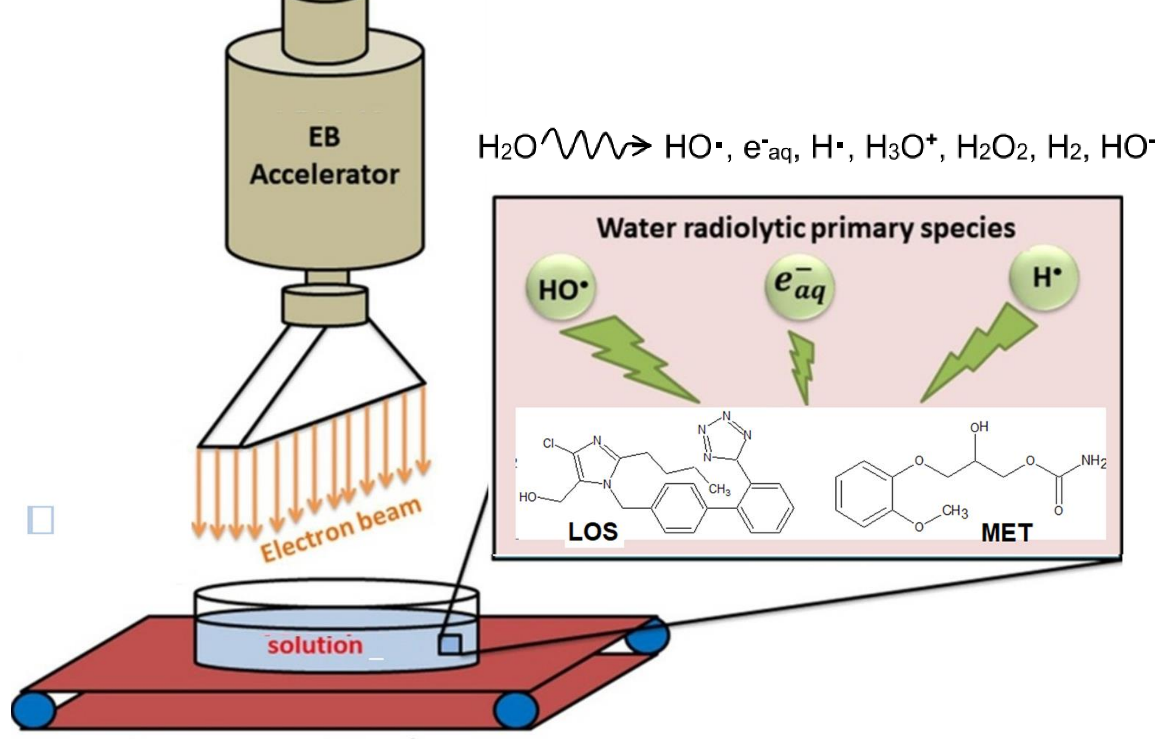
- Electron Beam irradiation was Investigated for the removal removal of two emerging pollutants Losartan and Methocarbamol in aqueous solutions.
- Irradiation was conducted by varying doses ranging from 0.5 to 4 kGy.
- Analysis monitoring changes in absorption spectra, Chemical Oxygen Demand (COD), and Total Organic Carbon (TOC) throughout the irradiation process were performed.
- Kinetic degradation study was carried out to assess the degradation rate constant of both organic compounds: Losartan and Methocarbamol.
- Identification of degradation by-products was performed using (LC/MS/MS) techniques.

Introduction

Losartan (LOS) is one of the most consumed antihypertensive drug all over the word. Methocarbamol (MET) is an analgesic widely used in recent decades. These medicines are classified as emerging contaminants, responsible for environmental damage and aquatic toxicity, that conventional wastewater treatment technologies are unable to successfully eliminate.

Irradiation Methodology

Aqueous solutions of LOS and MET were irradiated with an Electron Beam accelerator with 10 MeV energy at doses of 0 (control),0,5, 1, 2, 3 and 4 kGy. Irradiation treatments were conducted at room temperature (25 °C) and atmospheric pressure (1 atm).



Spectrophotometric Analysis

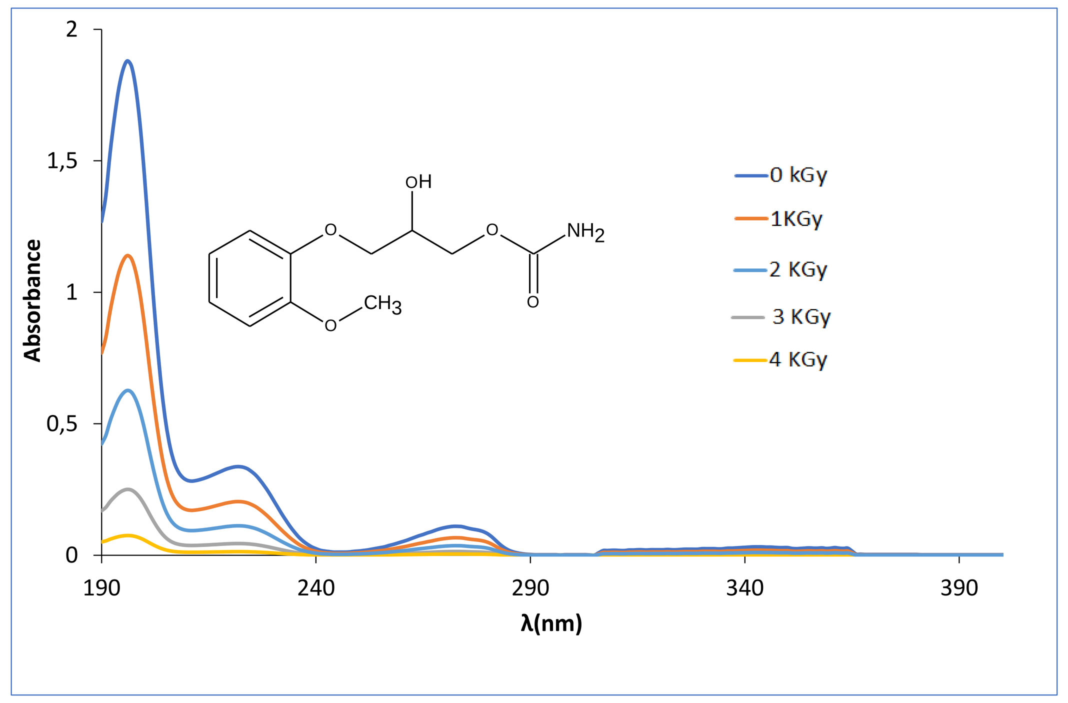


Figure 1: Evolution of UV-Visible spectra during E-Beam irradiation at different doses from 1 to 4 KGy.

Kinetic Study

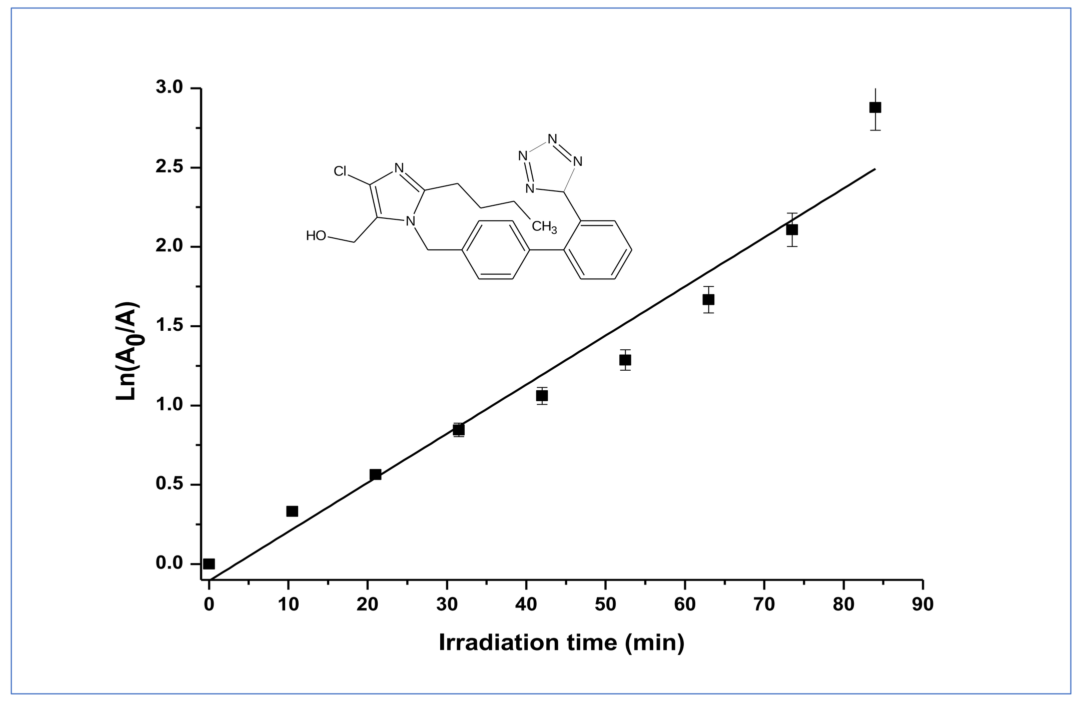


Figure 4: Ln (A_0/A) as a function as irradiation time

Effect of pH on Removal Efficiency

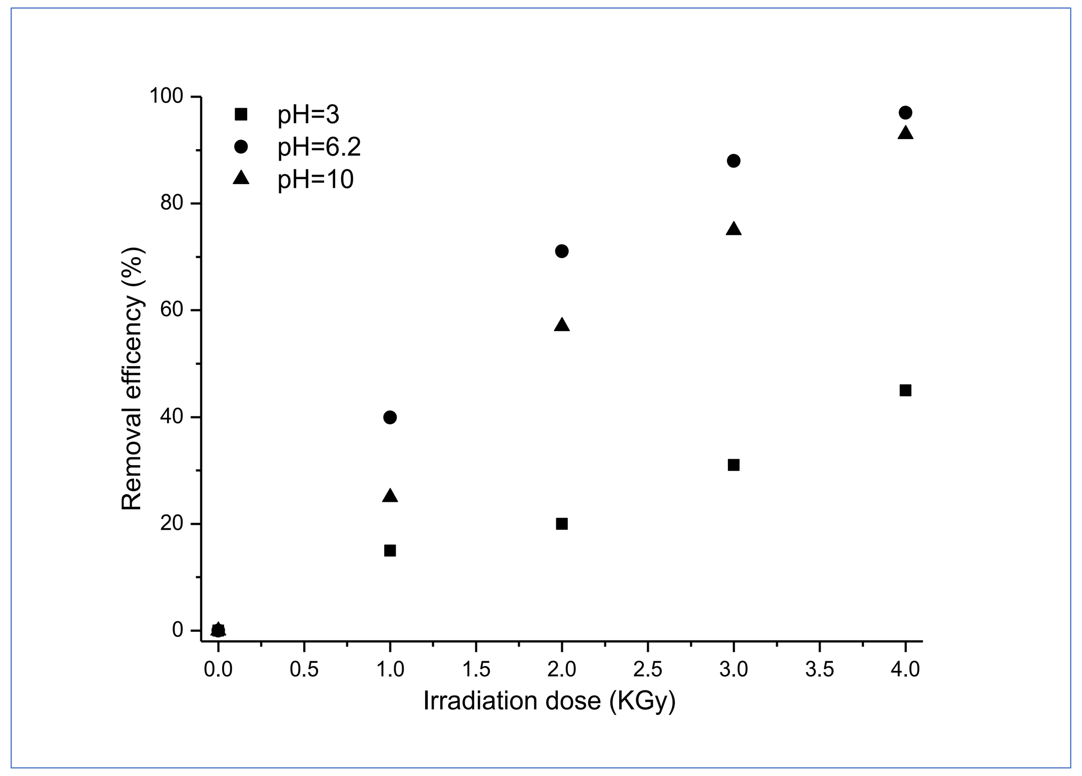


Figure 2: % of Elimination of MET at pH (pH=3; 6.2 and10). [MET] =1mM.

% COD and %TOC Removals

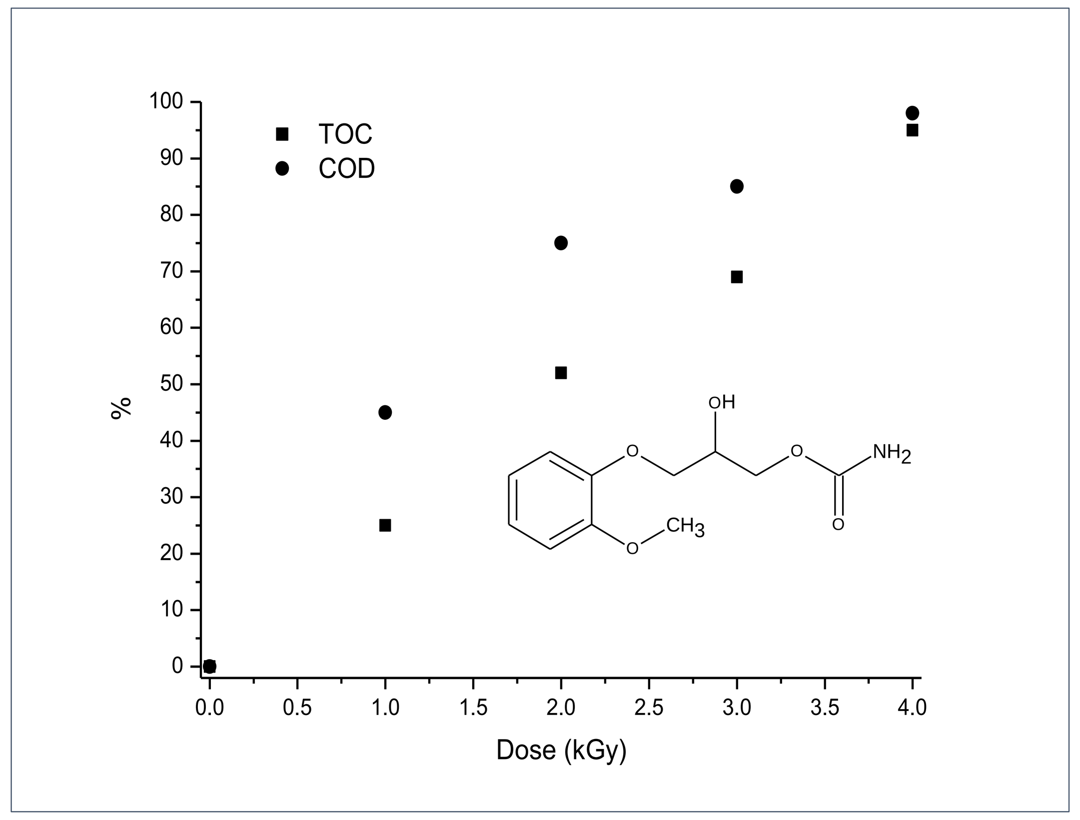


Figure 3: %TOC and % COD removals of MET aqueous solutions as a function as irradiation doses.

Proposed Mechanistic Schema of Losartan

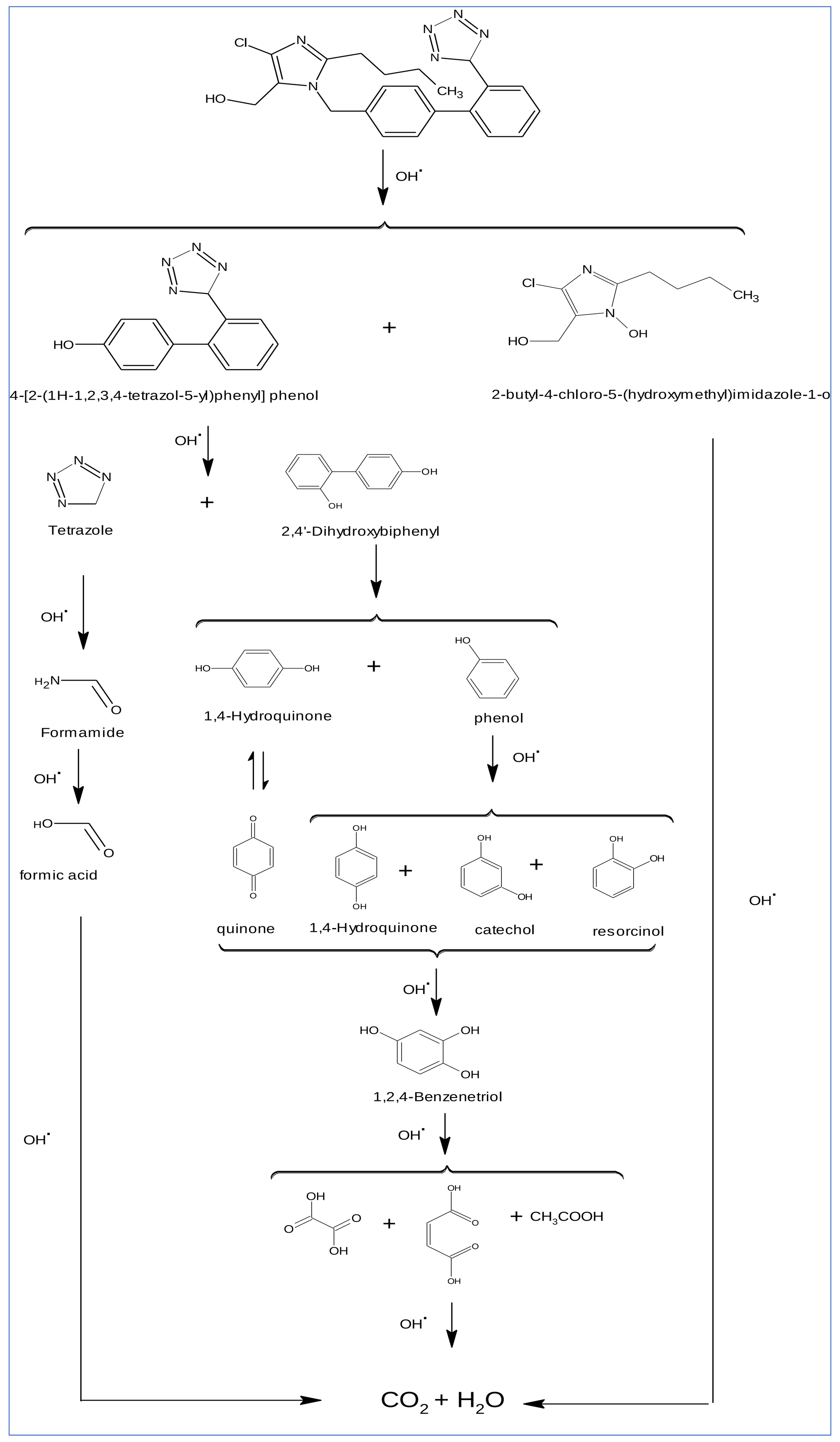


Figure 5: Proposed degradation pathway of LOS mediated by hydroxyl Radicals..

Results

- All absorbed bands decrease proportionally with increasing irradiation doses and disappear completely at 4 kGy. This gradual decrease indicates the fragmentation of molecules through the opening of aromatic rings, resulting in the formation of aliphatic compounds.
- pH alters H^+ and OH^- concentrations, affecting e^-_{aq}, H^+, and $^\bullet OH$ reactivity. Acidic pH results in lower efficiency due to rapid H^+ reaction with e^-_{aq}. Alkaline pH increases e^-_{aq} concentration, reducing hydroxyl radicals and enhancing organic compounds removal. At pH = 6.2, all reactive radicals contribute to higher removal efficiency.
- A linear behavior of Ln (A_0/(A) = k_{app} x t has been obtained for both compounds showing that the degradation process follows a pseudo-first order kinetic. The corresponding apparent rate constant value obtained is approximately $k_{app,MET}$ =(0.02167± 0.0006) min^{-1} and $k_{app,LOS}$ = (0.0309 ± 0.0025)) min^{-1}
- The removal efficiencies of COD and TOC were found to increase as the irradiation dose increased, reaching 98% for both MET and LOS after exposure to a dose of 4 kGy.
- Results prove the destruction of target molecule by degradation of the aromatic intermediates at the beginning of treatment, and then cleavage of the formed aliphatic intermediates before achieving total mineralization.
- The degradation was monitored using LC/MS, and all the by-products were identified for both compounds, facilitating the establishment of the degradation mechanistic scheme.

Conclusions

EB-irradiation proved to be an efficient and promising approach for the MET and LOS degradation in aqueous medium. MET and LOS degradations using EB-irradiation fit pseudo first-order kinetics model.

Electron beam irradiation emerges as a promising treatment method for addressing future emerging pollutants.

Acknowledgements

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