Photodegradation of drugs using gold nanoparticles for reduced environmental impact

Méndez Izares, Consuelo[1,2]; Hallett-Tapley, Geniece[3]; Silvero C., M. Jazmín[1,2]; Becerra, María Cecilia[1,2]

[1] Departamento de Ciencias Farmacéuticas, Facultad de Ciencias Químicas, Universidad Nacional de Córdoba, Av. Haya de la Torre esq. Medina Allende, Córdoba, Argentina.
[2] UNITEFA - CONICET, Unidad de Investigación y Desarrollo en Tecnología Farmacéutica - Consejo Nacional de Investigaciones Científicas y Técnicas, Ciudad Universitaria, Córdoba, Argentina.
[3] St. Francis Xavier University, Dept. of Chemistry, 5008 Chapel Square, Antigonish, Nova Scotia, B2G 2W5, Canada

consuelomendezizares@unc.edu.ar

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Current research suggests that conventional wastewater treatment plants (WWTPs) are often ineffective at removing pharmaceutical compounds, with up to 90% of these residues persisting in the final effluents [1]. Various research efforts have focused on optimizing the removal of pharmaceuticals accumulated in aquatic organisms and treatment plants using eco-friendly decontamination technologies based on biological and physicochemical processes. In this field, metal nanoparticles, particularly gold nanoparticles (AuNPs), stand out for their catalytic capacity under radiation [2].

The synthesis of the AuNPs was carried out using a cornstarch solution in less than 10 minutes at 80 °C. They were characterized using UV-Vis spectrophotometry, DLS, SEM, TEM, and EDS.3 The starch@AuNPs were obtained via a rapid synthesis in which starch was used as a reducing agent and stabilizer. The colloidal suspension was red in color with a maximum absorbance peak at 525 nm. DLS results indicate that 88% of the nanoparticles have a mean hydrodynamic size of 65 nm after synthesis. The presence of Au0 was confirmed by EDS mapping on SEM images. Their TEM images revealed a polymorphic size, with a heterogeneous size distribution and a mean size of 15–25 nm.

To enhance their catalytic capacity, they were immobilized on a hybrid support of titanium dioxide (TiO_2) and 3-mercaptopropionic acid (MPA). Photodegradation studies of ciprofloxacin, atenolol, and 17β-estradiol were conducted in the presence of starch@AuNP/MPA-TiO_2 in aqueous solution, with and without irradiation. The solutions were exposed to green light. Samples were taken at various intervals for up to 10 hours and immediately analyzed using HPLC methodology.

Photodegradation studies showed that the newly obtained catalyst achieved complete degradation of ciprofloxacin within 45 minutes of green light irradiation. Regarding atenolol and 17β-estradiol, significant degradation was observed at 120 minutes and 600 minutes, respectively.

In conclusion, a nanocatalyst based on AuNPs, MPA, and titanium oxide was synthesized using environmentally friendly methods, which enhanced the photodegradation of pharmaceutical contaminants within a few hours. This approach represents a sustainable and novel strategy for the development of future platforms for wastewater treatment.

Referencias

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