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SUITABILITY ASSESSMENT OF PHOTOCATALYTIC TREATMENT FOR PHARMACEUTICAL REMOVAL - STRENGTH, WEAKNESS, OPPORTUNITIES AND THREATS (SWOT) ANALYSIS

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Introduction

Important facts

- ✓ Although pharmaceuticals are released into the environment in high level, there is a significant shortcoming in the legislation.
- ✓ The low removal percentage of pharmaceutical components by applying conventional treatments.
- ✓ The goal of advanced oxidation techniques is the conversion into smaller molecules such as carbon dioxide and water thus achieving complete mineralization of the pollutant.

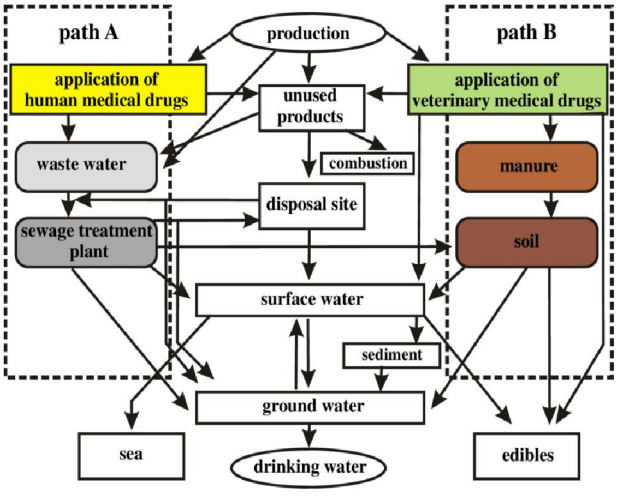
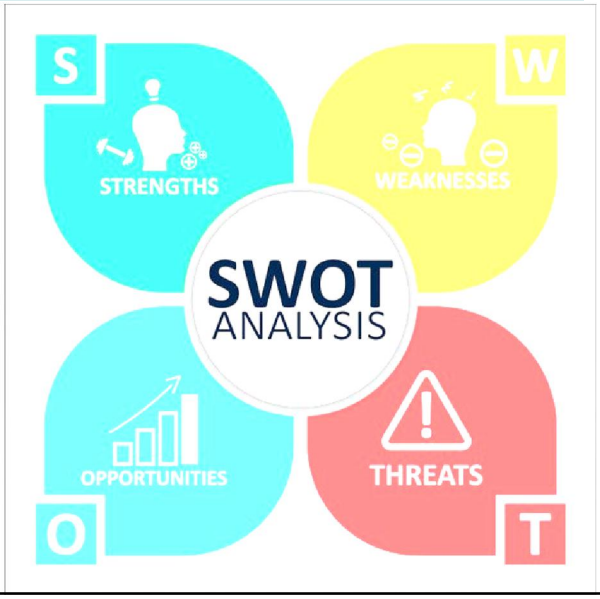


Figure 1. The major routes of pharmaceuticals in environment (Schlüsener, 2006)

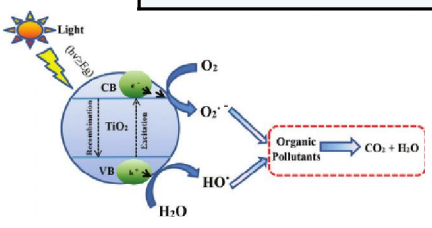
The aim of the study

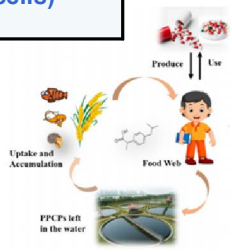
- ✓ Binary metal oxides systems (ZnO/SnO_2, ZnO/TiO_2 and ZnO/In_2O_3) had great potential to minimize concentration levels of NSAIDs and decompose them at maximum levels (Novakovic et al. 2019).
- ✓ The aim of this study was to determine the advantages and disadvantages of photocatalytic treatment of non-steroidal anti-inflammatory pollutants using a new nanostructured material in real systems.



Previous conducted experiments

LABORATORY EXPERIMENTS
Individual and competive experiments for photocatalytic decomposition of NSAIDs (pH, nanomaterial concentration, irradiation time, pharmaceutical concentration)
Influence of inorganic constituentes (sulfate, chlorides, phosphate and nitrate ions)
Identification of intermediates of photocatalytical degradation
Ecotoxicological tests for nanomaterials and selected NSAIDs (HepG2 cells)





Material and methods

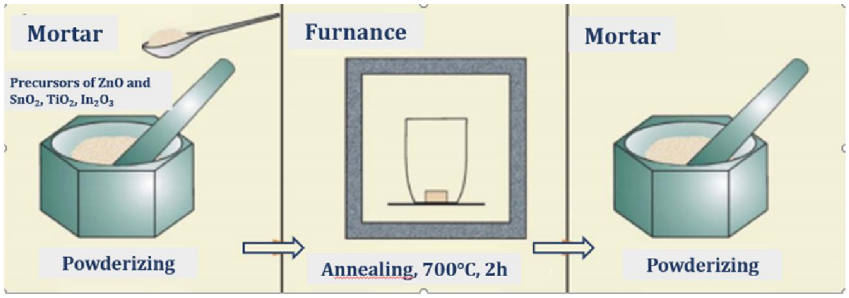


Figure 2. Three-step preparation of analyzed nanostructured materials (ZnO/SnO_2, ZnO/TiO_2 and ZnO/In_2O_3)

Material and methods

- ✓ Photocatalytic treatment of pharmaceutical mixture (ketoprofen, naproxen, diclofenac and ibuprofen) on laboratory scale.
- ✓ The one-hour period exposed to UV irradiation.
- ✓ The selected concentration of NSAIDs was 5 mg L^{-1}, while concentration of nanomaterial was 0,40 mg mL^{-1}.

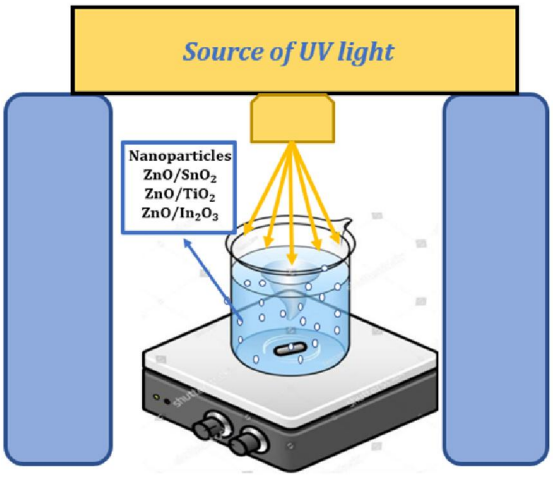


Figure 3. Decomposition of NSAIDs on laboratory scale

Results and discussion

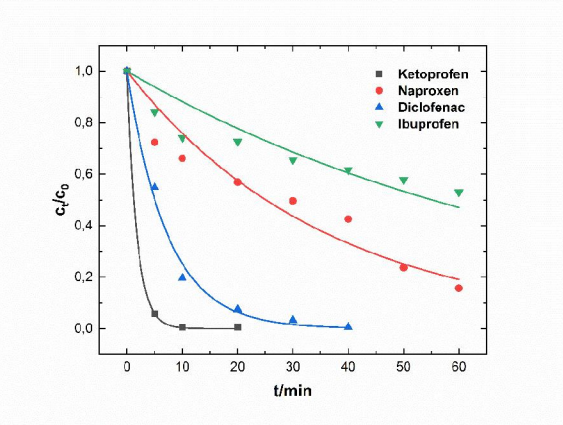


Figure 4. Photocatalytic decomposition of pharmaceutical mixture by ZnO/SnO_2 (c_0- initial concentration of pharmaceuticals (mg L^{-1}), c_t – concentration of pharmaceuticals at analyzed time intervals (mg L^{-1}), t – irradiation time (min))

Results and discussion

STRENGHTS

1. Simple synthesis of nanostructured materials.
2. Low concentration of selected nanomaterials required for efficient photocatalytic treatment.
3. An efficient and resistant process for most inorganic constituents (anions) present in aqueous media.
4. The possability of regeneration and re-use of nanomaterials in several photocatalytic cycles.
5. The photocatalytic intermediates and nanomaterials do not exhibit a cytotoxic effects on the tested medium.
6. Improved performance of nanostructured mixtures (reduction of recombination process).
7. Use of sunlight as source of irradiation.
8. Less toxic solid production.
9. Non-chemical technology.

WEAKNESSES

1. Incomplete mineralization of selected pharmaceuticals.
2. The need to separate the used nanoparticles at the end of treatment.
3. Incomplete photocatalytic degradation of ibuprofen and necessity of prolongation of the process.

OPPORTUNITIES

1. Reduction of the potential negative impact of the pharmaceutical micropollutants on the quality of aquatic ecosystems.
2. Possibility of application in real conditons of municipal wastewater treatment plant (as tertiary treatment).
3. Possibility of implementation of photocatalytic process in industrial plants (pharmaceutical).

THREATS

1. Final disposal of spent nanomaterials at the end of the life cycle (waste management).
2. Costs of instalation and number of UV lamps having in mind the capacity of the wastewater treatment plants.
3. The other organic contaminants might have impact on overall photocatalytic efficiency.
4. Necessary professional training to work on photoreactors.

Conclusion remarks

- ✓ The diverse and complex nature of pharmaceutical pollutants has a significant impact on their removal efficiency in wastewater treatment plants.
- ✓ Photocatalytic technology with analyzed nanostructured mixtures has been proven to be an effective technology for decomposition of non-steroidal anti-inflammatory pharmaceuticals.
- ✓ With performed SWOT analysis for selected advanced oxidation method, many strengths was determined which can be mirrored through simplicity of nanomaterial preparation not demanding high energy consumption, stability of nanomaterials under simulated condition which include presence of inorganic constituents such as anions present in real wastewater and non-chemical usage. Besides numerous strengths, photocatalytic technology has a few drawbacks.