

Bioremediation of industrial pollutants by white-rot fungi

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Introduction

- **Examples of recalcitrant organopollutants:**
 - Phenolic compounds
 - Paper mill wastewater
 - Olive mill wastewater
 - Synthetic dyes
 - Textile industry
 - Chlorinated compounds
 - Chlorinated aliphatic hydrocarbons (industrial cleaning)
 - Pentachlorophenol (wood preservative)
 - Polycyclic aromatic hydrocarbons (fossil fuels)
 - Emerging pollutants
 - Pharmaceutical, cosmetic, ...





Introduction

- **Main characteristics of those organopollutants:**
 - Synthetic origin
 - Low biodegradability
 - Inhibitor or toxic compounds
 - Low COD
 - Complex chemical structure containing aromatic ring or phenols
- **White rot fungi**
 - *Irpex lacteus*
 - *Phanerochaete chrysosporium*
 - *Trametes versicolor*



Introduction

- ***White-rot fungi***
 - Able to degrade lignin
 - Producer of non-specific intra and/or extracellular enzymes
 - Able to grow and produce enzymes in
 - Solid-state cultures
 - Submerged agitated cultures



Introduction

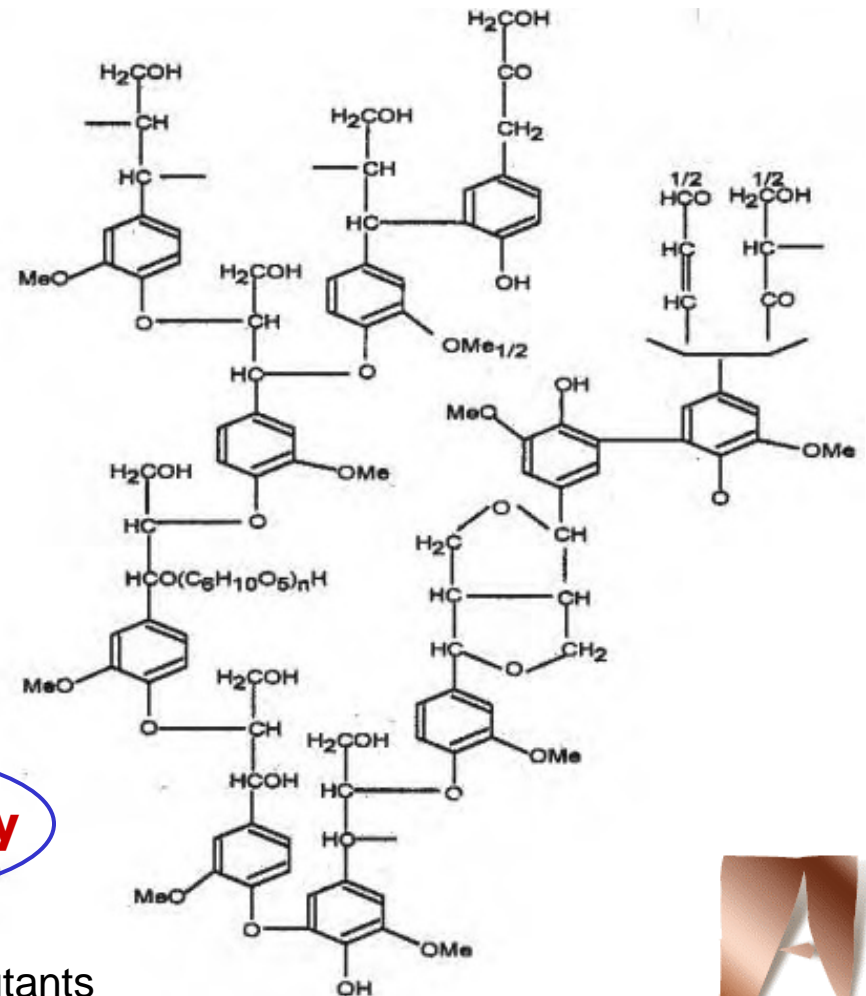
Lignin characteristics:

- 2n more abundant polymer
- Complex structure
- Wide variety of chemical bonds

Ligninolytic enzymes:

- lignin peroxidase
- manganese peroxidase
- versatil peroxidase
- laccase
- Cytochrom P450

Non-specificity



T. versicolor for bioremediation of industrial pollutants



Objectives

Basic aspects

Liquid medium

- capacity to degrade
- enzymes involved
- degradation products
- detoxification
- ...

Application

Wastewater

Contaminated soil

- operation conditions optimization
- bioreactor design
- operation mode
- ...

Process development

- pilot scale
- industrial conditions
- cost evaluation
- environmental impact
- ...





Applications

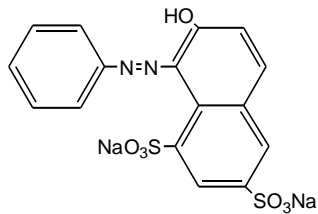
Several examples

- ✓ **Textile dyes**
- ✓ Polycyclic Aromatic Hydrocarbons (PAHs)
- ✓ Pharmaceutical and Personal Care Products (PPCP)

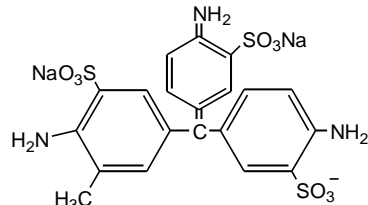
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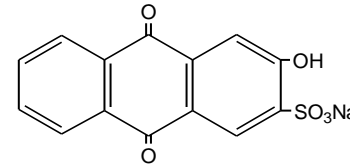
Fungus biodegradation of other textile dyes



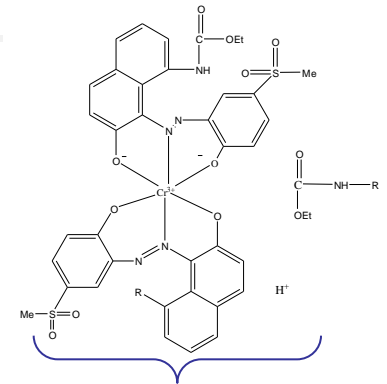
Orange G



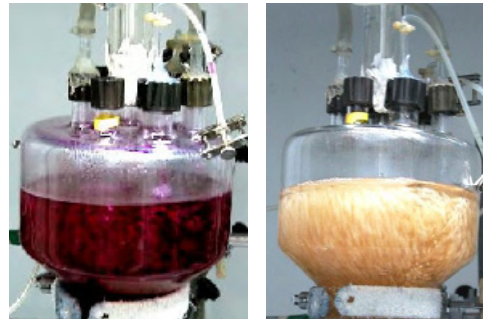
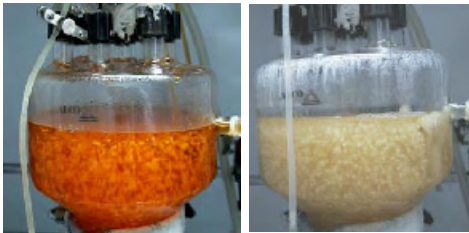
Acid Fuchsin



Alizarin Red S



Lanasyn Grey



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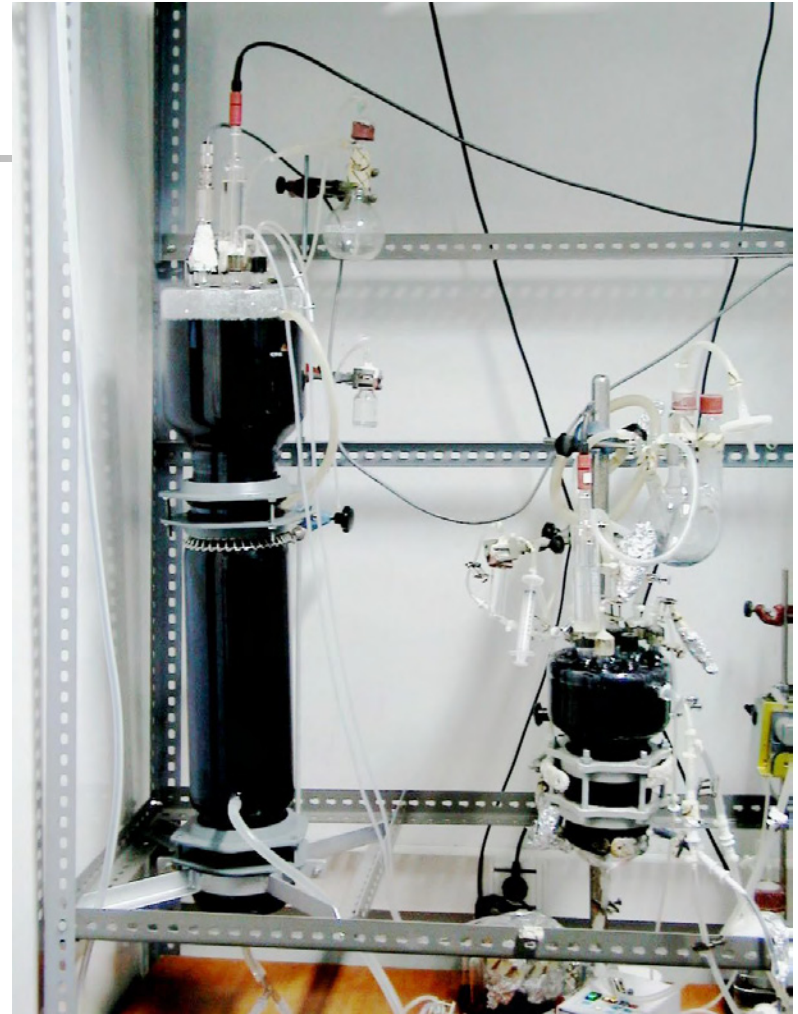
PILOT BIOREACTOR

Successfully operation in :

- lab scale
- pilot scale

Operational conditions :

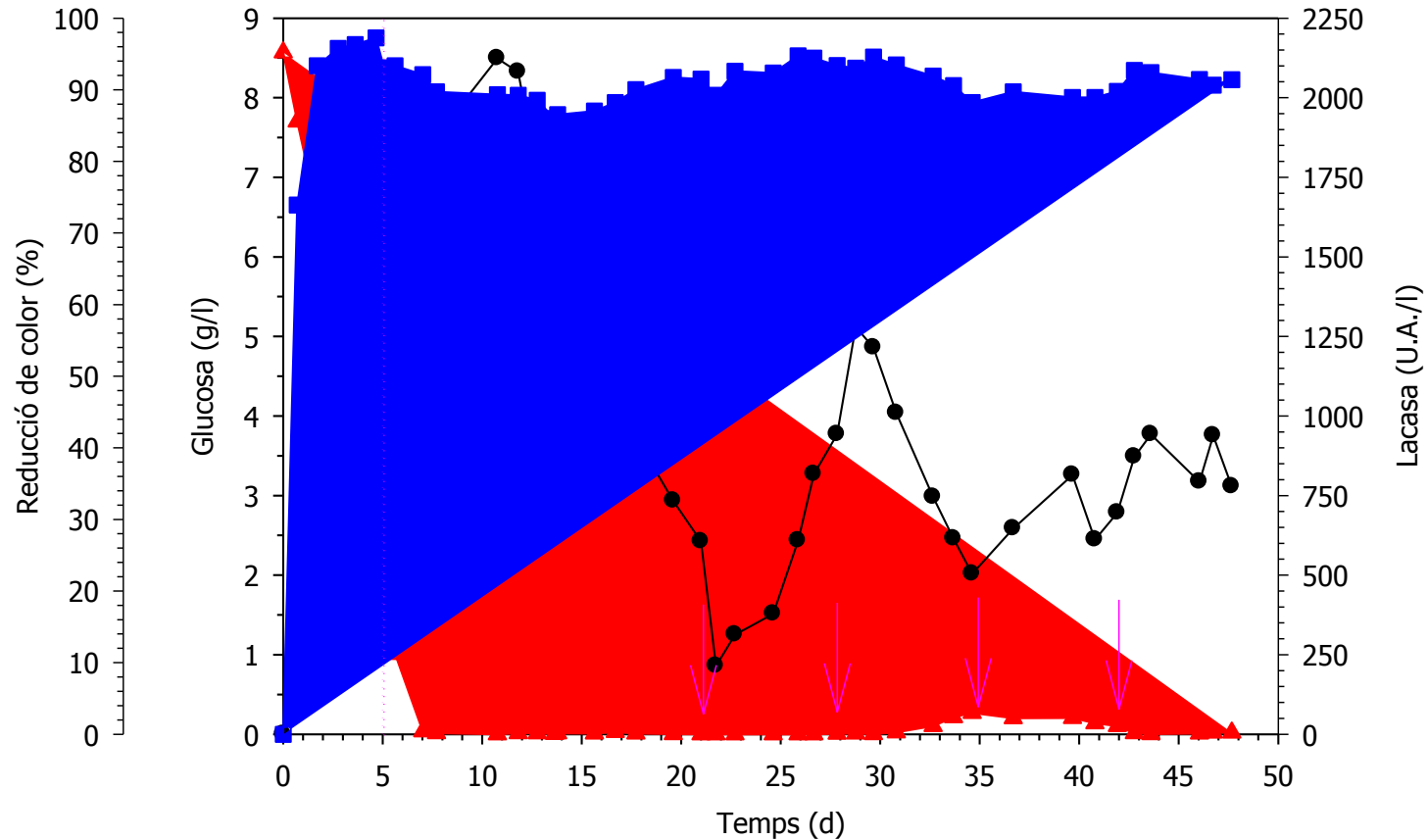
- Batch
- Sequential batch
- Continuous



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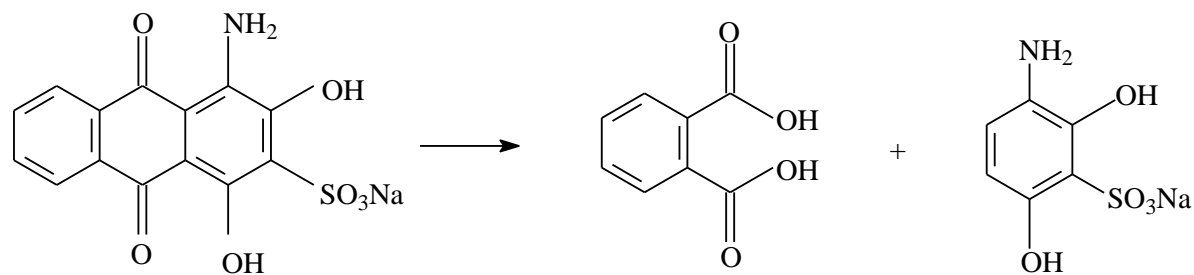
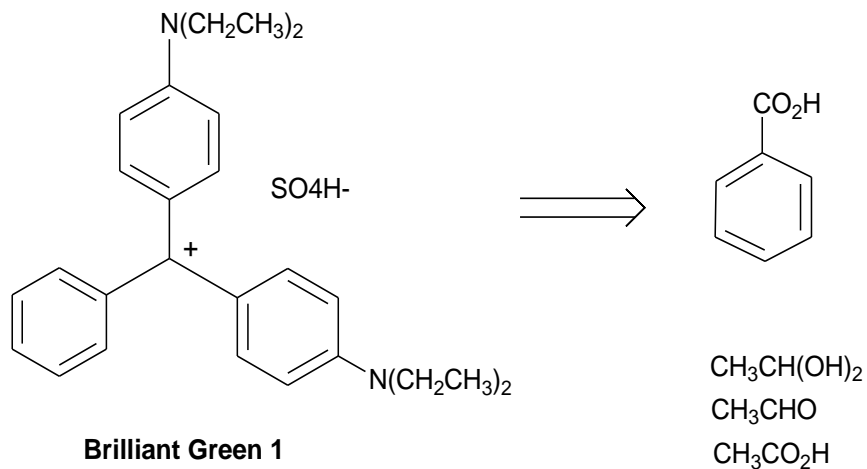
PARTIAL BIOMASS RENEW: CELLULAR RETENTION TIME 21 d



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Laccase degradation of textile dyes



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Results

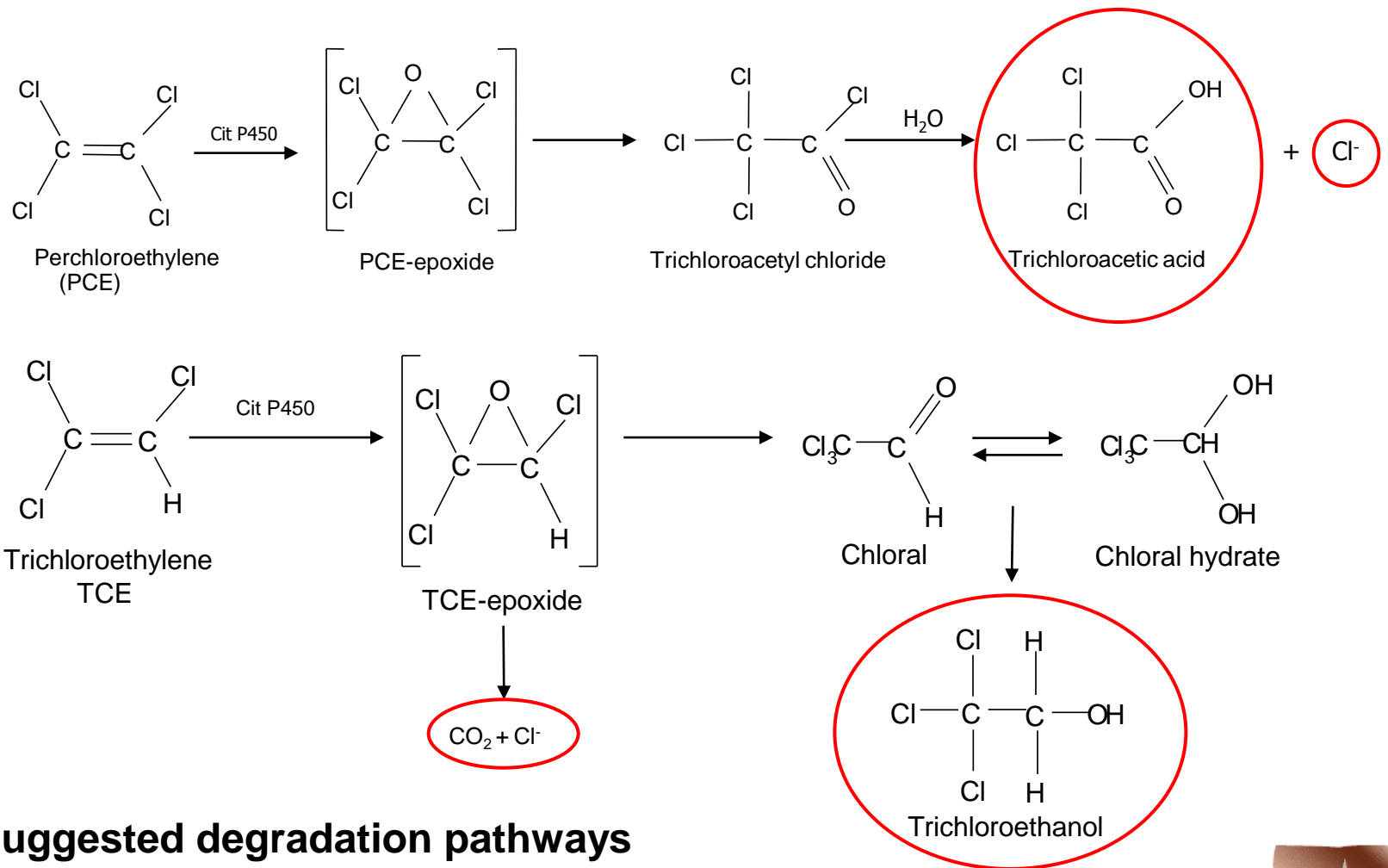
Several examples

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Pathways of biodegradation of PCE and TCE



Suggested degradation pathways

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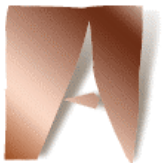


Results on recent topics

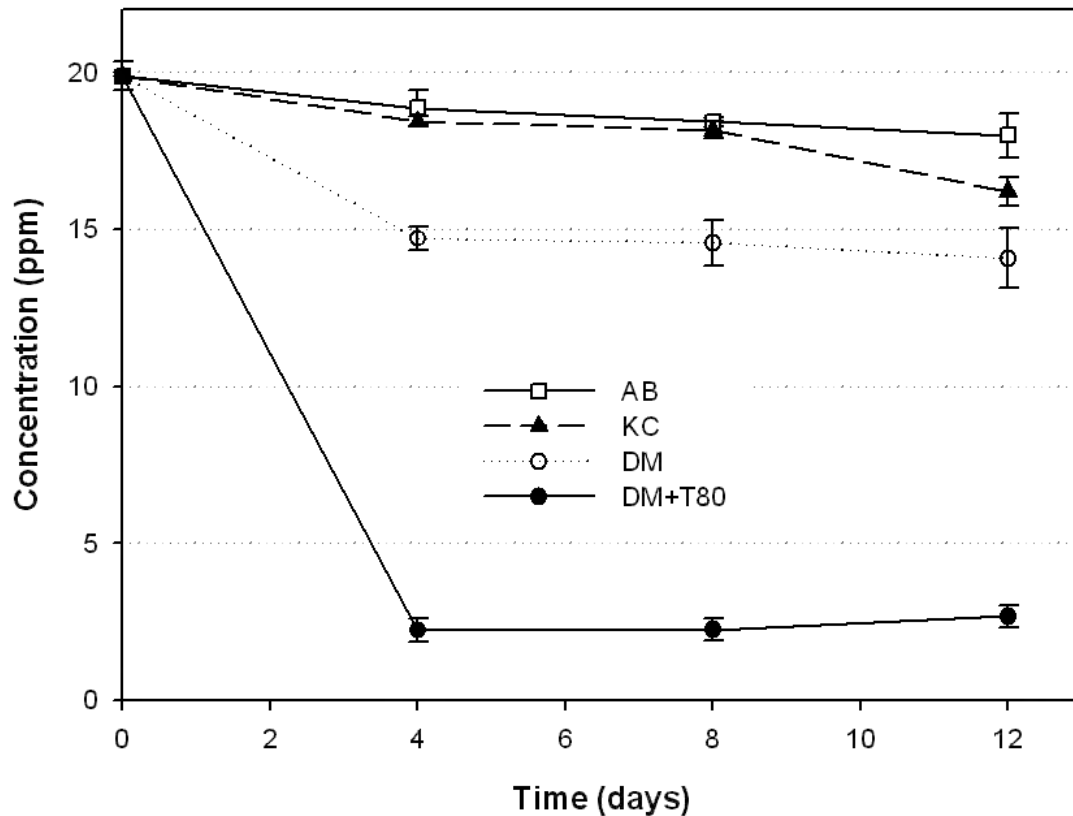
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Benzo[a]anthracene degradation in liquid medium



Biodegradation (%) at 12 days

Defined
medium
(DM)

DM +
T20

DM +
T80

17,63

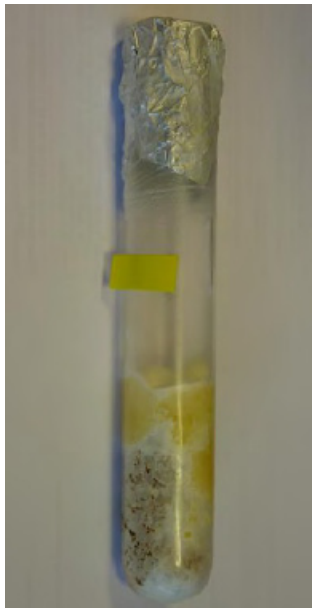
73,36

81,01

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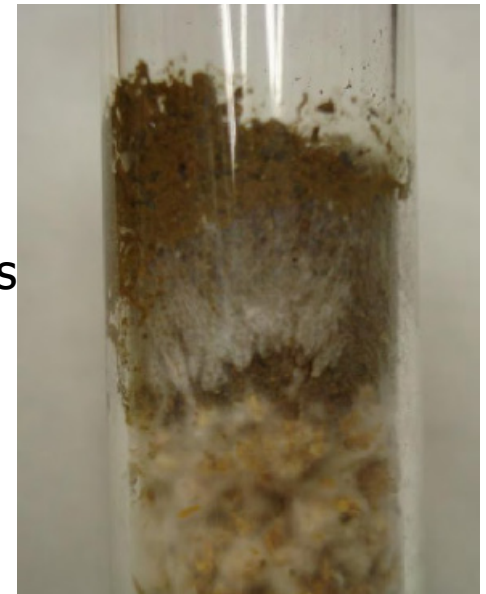
PAH degradation in soil



2-3 weeks →



5-10 weeks →



3 g pellets colza
3 mL H₂O
1 mL inoculum

Spiking soil with
PAH up to fixed
concentration
9 g soil

PAH Extraction
Biomass (ergosterol)
Laccase

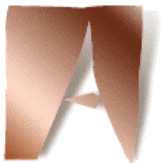


Results

Several examples

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- ✓ **Pharmaceutical and Personal Care Products (PPCP)**

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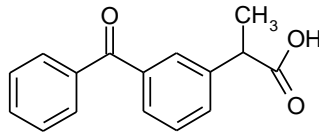


Emerging contaminants

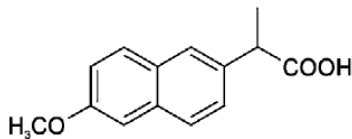
Def.: Products considered actually contaminants but no in the past; presents in constant manner in the environment at low concentration causing problems in the ecosystem and pending to be regulated en a next future.

➤ Pharmaceutical and Personal Care Products (PPCPs).

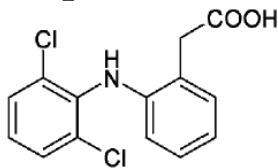
Pharmaceutics



Ketoprofen

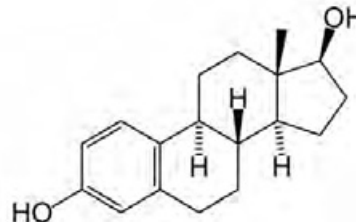


Naproxen



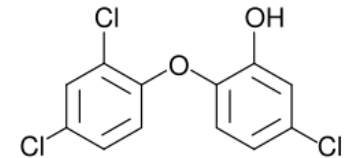
Dichlophenac

Hormones



17β-estradiol

Cosmetics



Triclosan

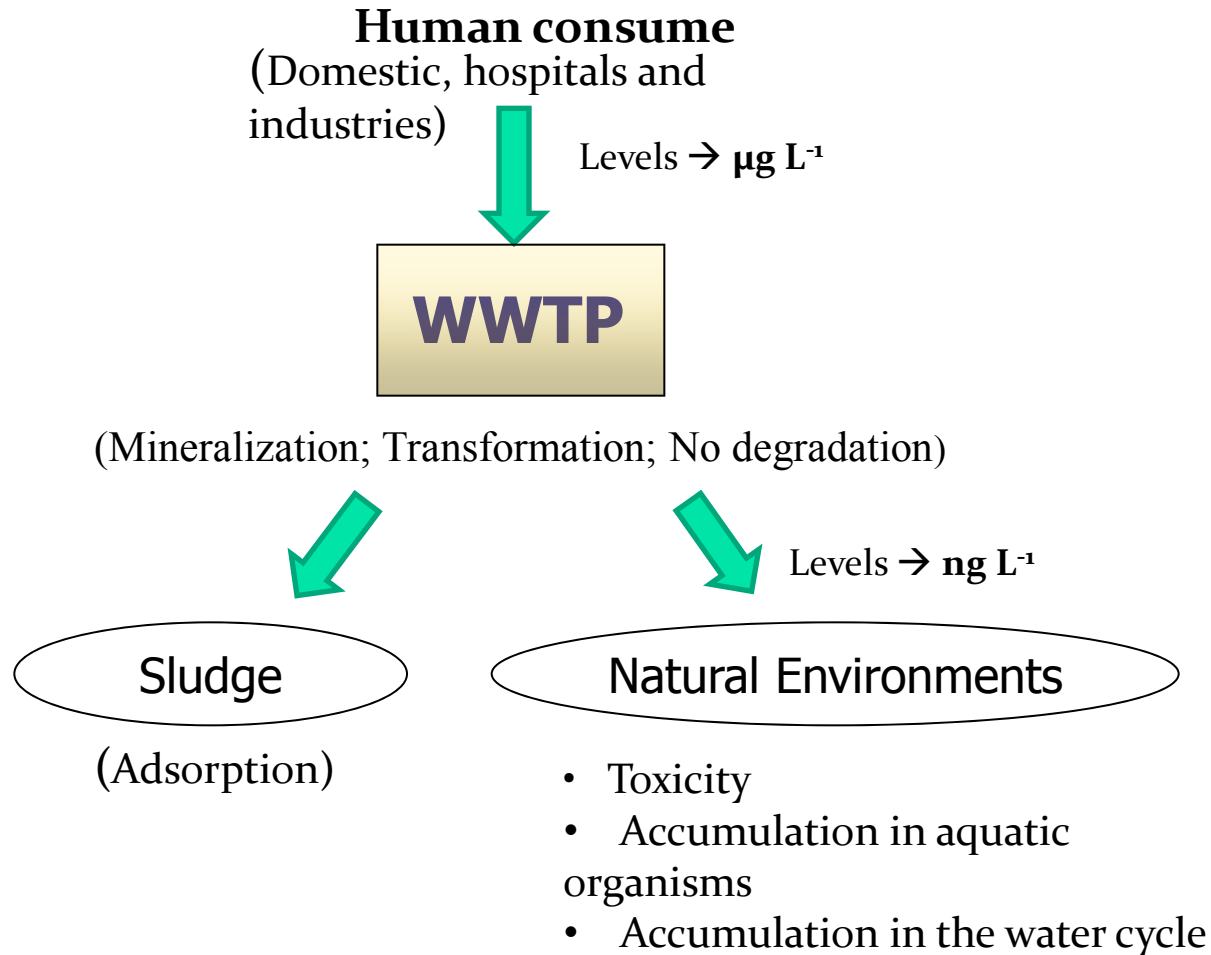


Nonilphenol

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Environmental problem of the emerging contaminants

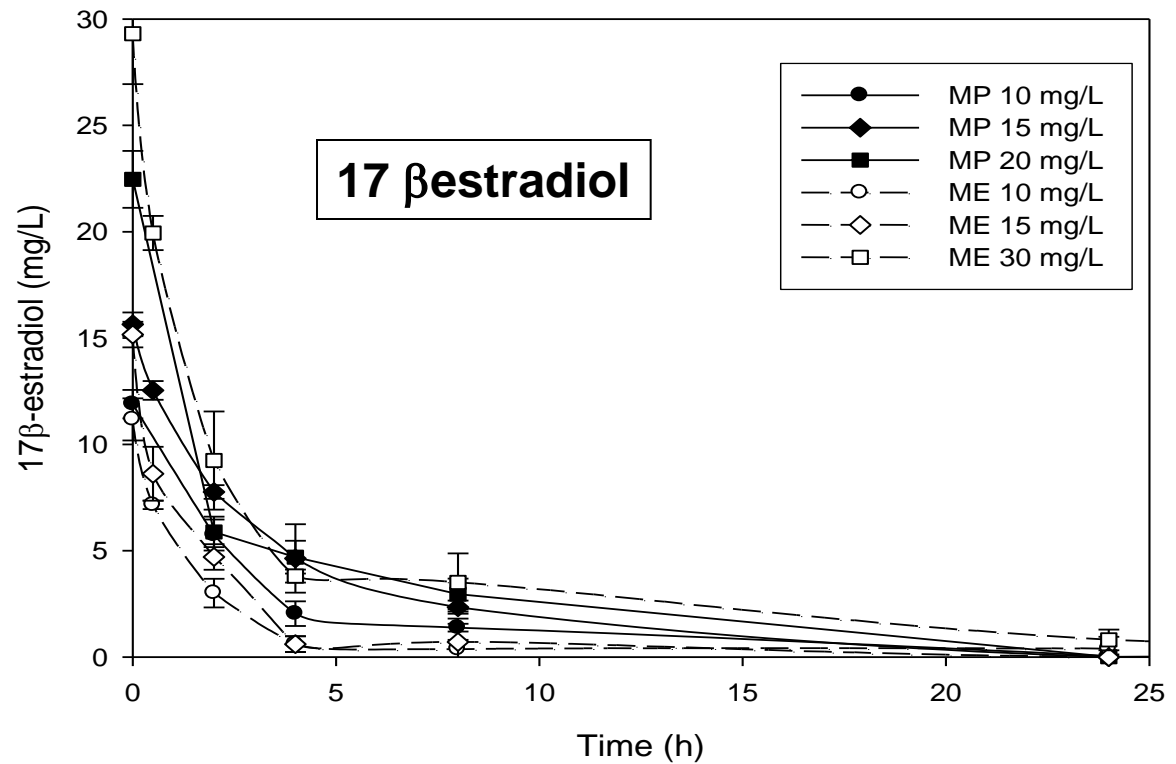


T. versicolor for bioremediation of industrial pollutants



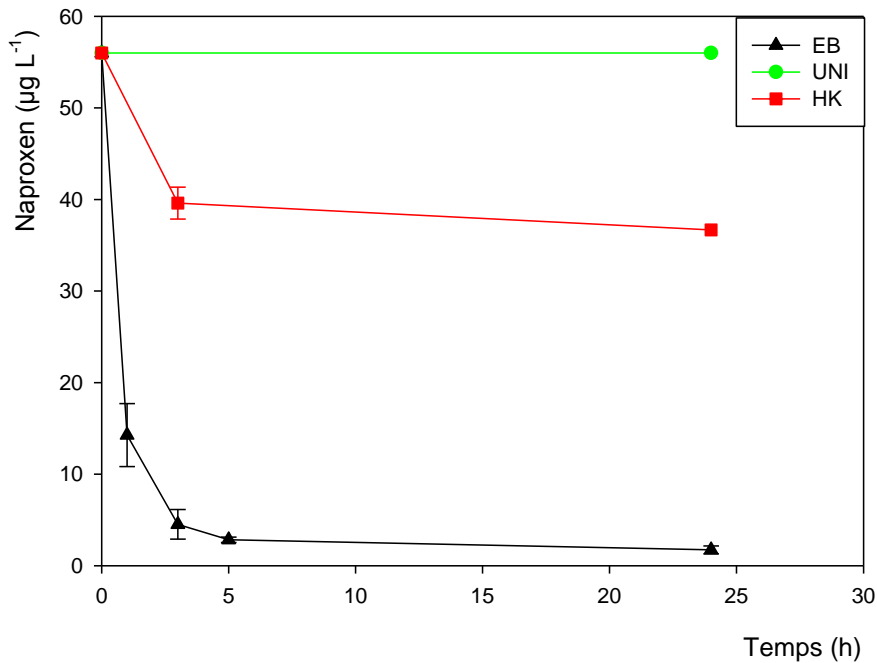
Degradation of emerging contaminants

**Basic studies about
the degradation in
liquid media**

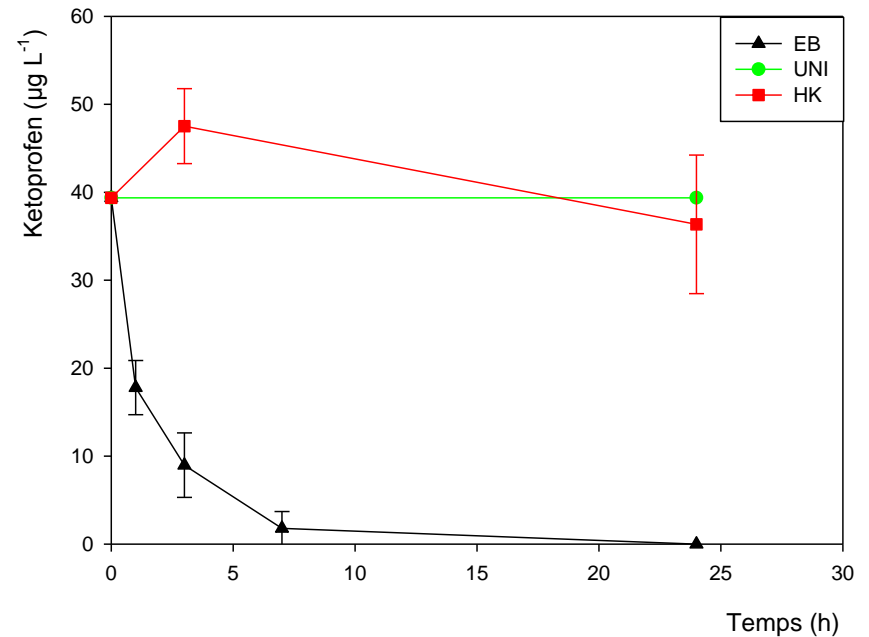


Degradation of emerging contaminants

Naproxen



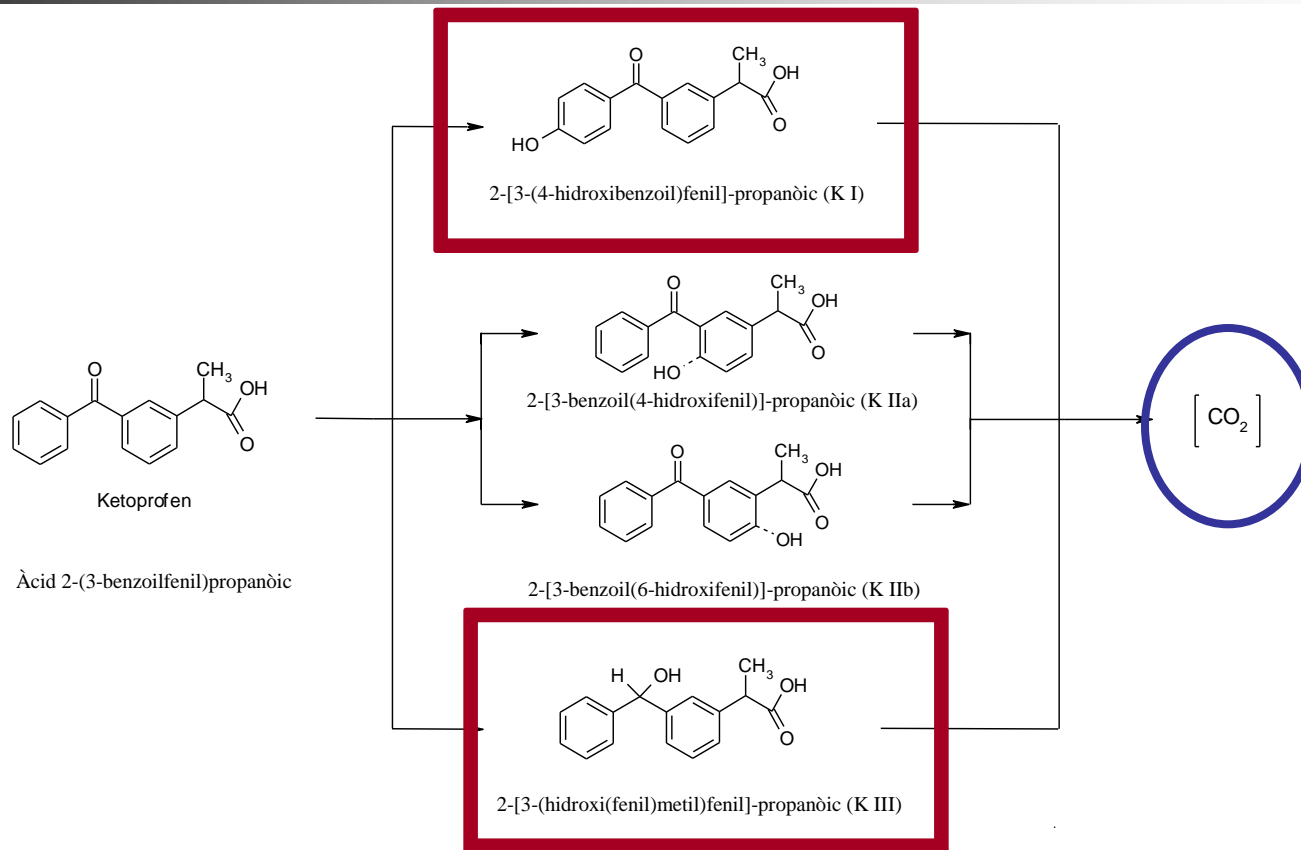
Ketoprofen



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Degradation of emerging contaminants



Possible degradation pathway for ketoprofen by *T. versicolor*

T. versicolor for bioremediation of industrial pollutants





Conclusions

- ❑ White-rot fungi, *Trametes versicolor*, and their complex enzymatic system are a promising tool for remediation of xenobiotic pollutants with very different chemical structures.
- ❑ Knowledge of the basic aspects related to the degradation allows its optimization.
- ❑ The development of a suitable bioremediation process is required according to the pollutant characteristics.





Use of the white-rot fungus *Trametes versicolor* for bioremediation of industrial pollutants

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Thank you for your attention