Biodegradation of wastewater textile dyes by recycling of immobilized fungus, isolated from forest, in a small-scale bioreactor

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Introduction

Dyes Colored substances
1000 dyes types - production 700000 (ton)/years
40% generated higher colored wastewater

Significant sources of water pollution

The use of dyes:
1. paper printing,
2. foods,
3. color photography,
4. textile dyeing,
5. pharmaceutical,
6. painting and,
7. other fields to support human daily-life.

Wastewater dyes
pH = 7.12
Solid cont. = 0.29%
Introduction

The objectives of study

Wastewater dyes

- to evaluate the ability of immobilize enzymes/fungus to decolorize wastewater dyes (*Trametes* sp. U97 & *Pestalotiopsis* sp. NG007)
- to decolorize wastewater dyes in a small scale bioreactor, as well as the effect of some factor (pH and flow rate) on decolorization
- to investigate the reusability of bead (immobilized fungus) on continues wastewater stimulation
Material & methods

Experimental design

Material & methods

Enzymes extraction

NG007 and U97, MnP or 1,2 D (0.36 and 1.08 mL)

Screening

Wastewater textile industries

Decolorization

Small Scale,

BIOREACTOR =

Immobilized Fungus U97

Results

Longevity, 5 times

Effect of flow rate (1.5 & 3 mL) & pH (4.5 & 7.12)

Shimadzu UV-VIS 1600

U97 or NG007

Homogenizer
(Malonate buffer pH 4.5)

Filtration

Ammonium sulfate (75%)

Centrifugation 8000 rpm, 20 min

Centrifugation
8000 rpm, 20 min

CRUDE ENZYMES

Re-dissolved

Liyophilization
**Material & methods**

**Culture preparation**
- Malt extract liquid medium, Autoclaving 121°C, 20 min (20 ml/flask)
- Potential Fungi screened from nature; U97 & NG007

- Culture flask
- Pre-INCUBATOR
- Crude enzyme (0.36 or 1.08 U mL⁻¹)
- Homogenized Fungus U97
- Immobilized fungus
- 0.1M CaCl₂
- 1.5% Na-Alginate

**Material & methods**

**Immobilized**
- Crude enzymes = 0.36 or 1.08 U mL⁻¹
  - MnP → *Trametes* sp. U97
  - 1.2 D → *Pestalotiopsis* sp NG007
- Culture fungus U97 → MnP = 1.41 U L⁻¹, Lac = 2.28 U L⁻¹

- Immobilized enzymes/Fungus
- Enzyme mediators:
  - (Tween 80, H₂O₂, Mn²⁺)
- Tween 80

w+x+y+z=20
**Material & methods**

Small-scale bioreactor

INCUBATED 25 °C for 1,2,3,6,24 h

UV/Vis Spectrophotometer

\[ R_{n(1,23)} = \frac{(A_{\text{initial}} - A_{\text{observed}})_n}{(A_{\text{initial}})_n} \times 100\% \]

\[ R = \text{Average } (R_1 ; R_2 ; R_3) \]

**Results and discussion**

**By Enzymes**

<table>
<thead>
<tr>
<th>Reaction time (hours)</th>
<th>Degradation (%)</th>
<th>Degradation (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>A. F. partially</td>
<td>E. F. partially</td>
</tr>
<tr>
<td>1</td>
<td>26.35 ± 3.32</td>
<td>14.15 ± 5.82</td>
</tr>
<tr>
<td>2</td>
<td>26.70 ± 2.27</td>
<td>14.52 ± 6.48</td>
</tr>
<tr>
<td>3</td>
<td>36.36 ± 2.71</td>
<td>14.85 ± 3.15</td>
</tr>
<tr>
<td>6</td>
<td>34.34 ± 4.31</td>
<td>20.54 ± 6.11</td>
</tr>
<tr>
<td>24</td>
<td>49.34 ± 4.35</td>
<td>35.66 ± 5.35</td>
</tr>
</tbody>
</table>

**By Enzymes & Fungus**

<table>
<thead>
<tr>
<th>Reaction time (hours)</th>
<th>Immobilized enzyme</th>
<th>Immobilized cell of fungus</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>54.23 ± 4.31</td>
<td>57.03 ± 3.16</td>
</tr>
<tr>
<td>2</td>
<td>36.94 ± 4.00</td>
<td>52.04 ± 3.51</td>
</tr>
<tr>
<td>3</td>
<td>50.04 ± 3.51</td>
<td>47.22 ± 1.66</td>
</tr>
<tr>
<td>6</td>
<td>44.74 ± 5.90</td>
<td>88.35 ± 2.03</td>
</tr>
<tr>
<td>24</td>
<td>57.03 ± 3.16</td>
<td>94.34 ± 4.35</td>
</tr>
</tbody>
</table>

Before | After | After | After | Before | After
**Results and discussion**

**Effect of flow rate & pH**

Before | After | After | Before
--- | --- | --- | ---
![Image of beakers showing before and after conditions](image)

**Results and discussion**

**Sequencing batch**

Before | After
--- | ---
![Image of beakers showing before and after conditions](image)
The decolorization of dyes is depending on the presence of enzymes, flow rate of bioreactor, pH, types of textile dyes and present of catalysis mediator.

MnP from *Trametes* sp. U97 to be more powerful than 1,2-D from *Pestalotiopsis* sp. NG007.

The immobilized fungus *Trametes* sp. U97 was more efficient to decolorize wastewater dyes than enzyme itself, manganese peroxidase especially.

The immobilized cell of fungus U97 is a potential alternative to handle colour wastewater of textile industries in small-scale bioreactor.

**Thanks You**