IMPACT OF TANNERY EFFLUENT ON BIOCHEMICAL PARAMETERS OF *Brassica juncea*

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Abstract

The tannery effluent is a mixture of biogenic matter of hides and a large variety of organic and inorganic chemicals. It usually contains high concentration of toxic metals like copper, chromium, zinc, cadmium, nickel and chemicals like aliphatic sulfonates and cyanides. The use of plants for bioremediation is called as phytoremediation. It involves the use of green plants to decontaminate soil, water and air. It is a cost effective process and the end products are nonhazardous. In the present study a hyper accumulating plant *Brassica juncea* was grown in different concentrations of effluent and their biochemical parameters carotenoid, chlorophyll, chromium, nickel and zinc were analyzed in leaves, stem and seeds. The results show that the heavy metal contents were higher in stem compared to leaves indicating the transports of these are high in stem. Chlorophyll and carotenoid contents of plants treated with 25 per cent effluent was higher compared to 50 per cent effluent treated plants. Higher the dilution lesser the harmful effect of effluent on the plants.

Key words: Tannery effluent, *Brassica juncea*, phytoremediation

Introduction

In the past years, industrial activities have grown rapidly. The increasing contamination of urban and industrial wastewaters with toxic metal ions is a serious environmental problem (Santhy and Selvapathy, 2004).

Tannery industry uses a large amount of water and only a small fraction is consumed by the products and the rest finds its way into the water courses as waste water. Pollution potential of these wastes arises from high concentration of chemicals used during the tanning operation.

The impact of leather tanning industry on the environments is an ongoing and increasing problem (Lofrano et al., 2008). Tanning industry is one of the oldest industries in India (Marippan and Rajan, 2002). India stands tenth in the world in its foot wear production and is one of the highest producer of raw skin and hide. There are more than 2500 tanneries in the country and nearly 80% of the tanneries are engaged...
in chrome tanning process (Gupta and Sinha, 2006).

Phytoremediation, use of proper plants to clean contaminate sites is an emerging technology that employs the use of plants for clearing the contaminated areas. Plant cultivation and harvesting are inexpensive processes compared with traditional engineering approaches involving intense soil manipulations (Nouri et al., 2009).

Hyper tolerance of metals is the key plant characteristic required for hyper accumulation and the hyper tolerant capacity of plants to heavy metals depends on an interrelated network of physiological and molecular mechanisms. One of the characteristics that make a plant species tolerant to heavy metal stress is the presence of a strong antioxidant defense system (Metwally et al., 2005) (Israr et al., 2006). Clemente et al., (2005) examined plants with high speed of growth from the Brassicaceae family for their ability to tolerate and accumulate the metals including, Brassica juncea, Brassica campestri, Brassica napus and Brassica oleracea. Brassica juncea selected for the study is a local species, easily available and is found to be tolerant to both the cadmium and chromium metals.

**Materials and Methods**

The effluent was collected from a leather processing industry, Dindigul district at regular intervals and stored at 4°C for analysis. The effluent was diluted to 25% and 50% concentrations for the use of pot study. The seeds of the plant sample Brassica juncea selected for the study were collected from Tamil Nadu Agriculture University, Coimbatore.

The experiment was conducted for 100 days. The leaves and stem were collected after a period of 30, 60 and 90 days and analyzed for certain biochemical parameters. Parameters, method of analysis and references are presented in table 1.

**Estimation of carotenoids**

Sample was extracted with 12% KOH and saponified. It was mixed with petroleum ether in a separating funnel. The petroleum layer with carotenoid was taken and the aqueous phase was repeated for separation with petroleum ether until colorless. Finally sodium sulphate was added to the ether phase and read at absorbance 450 and 503 nm in a spectrometer using petroleum ether as a blank.

**For total carotenoids**

Amount of total carotenoids present = \( \frac{P \times 4 \times V \times 100}{W} \) μg
Where,

\( P \) - Optical density of the sample

\( V \) - Volume of the sample

\( W \) - Weight of the sample

**Estimation of chlorophyll**

The leaves were analyzed for chlorophyll content by homogenizing 200mg of leaves in 80% acetone and the extract was centrifuged and the supernatant was analyzed for chlorophyll content in a spectrophotometer (Spectronic 20), at wavelength 645nm for chlorophyll with 80% acetone as blank.

**Extraction of metals from plant samples**

The harvested plant was crushed into powder and incinerated at high temperature. The ash obtained from the incinerated plant samples were treated with concentrated HCl and the metals analyzed using Atomic Absorption Spectrometer (AAS) according to APHA (1990).

Two way ANOVA was carried out between the treatment and days for the biochemical parameters.

**Results and Discussion**

Table 2 shows the chlorophyll and carotenoid contents in the leaves of *Brassica juncea*. From the table it was found that chlorophyll content in the control leaves were 2.03, 4.8 and 6.98 mg/g in the leaf samples of 30, 60 and 90 days plant. Values seem to decrease in the plants grown with 25 per cent effluent compared to control plants. A significant reduction in chlorophyll content was observed in plants grown in 50 per cent effluent compared to control and plants grown with 25 per cent effluent. Similarly carotenoid of the leaves was found to be significantly decreased in 25 per cent and 50 per cent effluent treated leaves than the control leaves.

Sinha et al., (2007) reported that, the effect of metals in the effluent showed a decrease in total chlorophyll, carotenoid and protein concentration in the leaves of *Vigna radiata* when compared to control plants.

Table 3 shows the levels of zinc, nickel, cadmium, copper and chromium in leaves and stem of *Brassica juncea*. Brassica family has the ability to transport copper, zinc, nickel, chromium and copper from its roots up to its stem. Absorption of the metals through stem to leaves reveals that concentrations of zinc, nickel, cadmium, copper and chromium in leaves were lesser than the values in stem. Distribution of metals from the soils reaches the stem but less is transported to leaves. Among the control and effluent treated plants leaves of 50% effluent treated plants had a significantly higher concentration of metals compared to the plants grown in 25%
effluent. Similar significant difference was observed in the stem of effluent treated plants with the control plants.

According to Angelova and Ivanov (2008) *Brassica juncea* showed highest ability to accumulate and transport copper, cadmium, nickel, chromium lead and zinc towards their stem which was also came to concordance with this present study

**Conclusion**

Industrialization is although a boon for developing countries like India, its effect on environment is equally dangerous. The industrial effluents discharged are highly eco toxic causing ecological imbalances in the environment. Hence there is a need to remediate the contaminated environment with eco-friendly techniques.

Heavy metal contamination is caused by natural process or by human activity is one of the serious eco toxicological problems. Contamination of soil and heavy metals is a serious concern in environmental perspective for safe utilization in agriculture. The results of biochemical analysis showed that the chlorophyll, carotenoid and protein content of the leaves of 25 per cent effluent treated plants were higher when compared with the leaves of 50 per cent effluent treated plants.

The concentration of metals such as chromium, nickel, zinc, copper and cadmium were found to be lower in the leaves of 25 per cent effluent treated plants compared with the leaves of 50 per cent effluent treated plants. Metal levels in the stem of the effluent treated plants were higher than in the leaves which indicates that the plants can accumulate more amount of metals in stem than in leaves.

Besides the medicinal value, *Brassica juncea* can be cultivated in the tannery effluent contaminated sites. This plant might be used to remediate the contamination and make society clean and healthy. This would play a vital role in remediating polluted system and preventing further contamination. Thus the plant can have beneficial practical application in remediation and recovery operations and reuse of metals bound with plant biomass

**References**


### Table 1: Biochemical parameters analyzed in *Brassica juncea*

<table>
<thead>
<tr>
<th>Parameters</th>
<th>Plant samples analyzed</th>
<th>Method of analysis</th>
<th>References</th>
</tr>
</thead>
<tbody>
<tr>
<td>Chromium, Copper, Cadmium, Nickel and Zinc</td>
<td>Leaves and stem</td>
<td>Spectrophotometric method</td>
<td>APHA 1998</td>
</tr>
<tr>
<td>Chlorophyll</td>
<td>Leaves</td>
<td>Spectrophotometry</td>
<td>Yoshida <em>et al,</em> 1971</td>
</tr>
<tr>
<td>Carotenoid</td>
<td>Leaves</td>
<td>Spectrophotometry</td>
<td>Zakaria <em>et al,</em> 1979</td>
</tr>
</tbody>
</table>

### Table 2: Chlorophyll and carotenoid contents of the leaves of *Brassica juncea* plant treated with effluent

<table>
<thead>
<tr>
<th>Treatment/days</th>
<th>Chlorophyll (mg/g)</th>
<th>Carotenoid (mg/g)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>30</td>
<td>60</td>
</tr>
<tr>
<td>Control</td>
<td>2.03</td>
<td>4.8</td>
</tr>
<tr>
<td>25% effluent</td>
<td>1.55</td>
<td>3.05</td>
</tr>
<tr>
<td>50% effluent</td>
<td>0.99</td>
<td>2.1</td>
</tr>
<tr>
<td>CD (0.05)</td>
<td>0.68</td>
<td></td>
</tr>
</tbody>
</table>

### Table 3: Zinc, nickel, cadmium, copper and chromium contents in leaves and stem of *Brassica juncea* (mg/g)

<table>
<thead>
<tr>
<th></th>
<th>Zinc</th>
<th>Nickel</th>
<th>Cadmium</th>
<th>Copper</th>
<th>Chromium</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Leaves</td>
<td>Stem</td>
<td>Leaves</td>
<td>Stem</td>
<td>Leaves</td>
</tr>
<tr>
<td>Control</td>
<td>0.36</td>
<td>0.58</td>
<td>0.54</td>
<td>0.55</td>
<td>0.44</td>
</tr>
<tr>
<td>25% effluent</td>
<td>8.1</td>
<td>9.7</td>
<td>9.1</td>
<td>10.1</td>
<td>9.1</td>
</tr>
<tr>
<td>50% effluent</td>
<td>12.2</td>
<td>13.1</td>
<td>13.2</td>
<td>14.2</td>
<td>11.2</td>
</tr>
<tr>
<td>CD (0.05)</td>
<td></td>
<td></td>
<td></td>
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</tr>
</tbody>
</table>

Values are mean of triplicates