DEPURATION OF TANNERY EFFLUENT BY PHYTOREMEDIATION AND INFILTRATION PERCOLATION UNDER ARID CLIMATE

S. Tiglyene[*1], A. Jaouad[2], L. Mandi[3]

[1-2] University Cadi ayyad, Faculty of Sciences Semlalia, BP 2390 Marrakech, Morocco.
[3] National Center for Studies and Research on Water and Energy, Marrakech, Morocco.
e-mail: mandi@ ucam.ac.ma

Abstract

The specific aims of this work were on the one hand, to investigate the potential of *Phragmites australis* to remove chromium from diluted tannery wastewater (50%) in comparison to unplanted soil, under arid climate conditions. Dilution is made by well water. On the other hand, to study the treatment of raw tannery effluent by infiltration percolation system.

The results indicated that during 13 months of experiment, total chromium undergoes an overall removal of 99% for the two pilots, which provides limpid purified water. The results of the distribution of total chromium in the various strata of constructed red bed indicated a significant accumulation of total Cr reaching 80% in the surface strata for two systems. Furthermore, the results showed that the Cr could migrate also towards deeper levels of the soil. After 13 months of experiment, the soil accumulated high content of chromium: 94% and 98% for the planted and unplanted systems respectively. However, 5% of Cr accumulated in *Phragmites australis.* The results also showed that *Phragmites australis* accumulated 1690 mg/kg dry matter of chromium in the roots. The treatment of tannery effluent by reed bed combined with infiltration percolation system is a clean approach from an ecological point of view and constitutes a viable economic alternative in comparison to the purely chemical approaches for the treatment of tannery effluents.

Key-words: tannery, chromium, *Phragmites australis*, infiltration-percolation, treatment, arid climate.

Introduction

The leather tannery industry is well known for having a severe negative impact on the environment. In this industry animal hides are transformed into leather in a succession of various complex stages, consuming high quantities of water and using large amounts of such chemicals as lime, sodium chloride and chromium salts. The most dangerous problem of the pollution generated by the tannery industries in Marrakech is the discharge of heavy metal into the environment, mainly the chromium (≈40 tons/year) which is able to disturb the biological breakdown of the effluents (Scandiaconsult International, 1999). Tannery wastewater flows directly into the receiving medium without any preliminary treatment.

The objective of this study is to investigate the potential of an helophytic plant *Phragmites australis* (Cav.) Trin ex Steudel to remove chromium from concentrated tannery effluent in comparison to unplanted soil, under arid climate conditions.

Methods

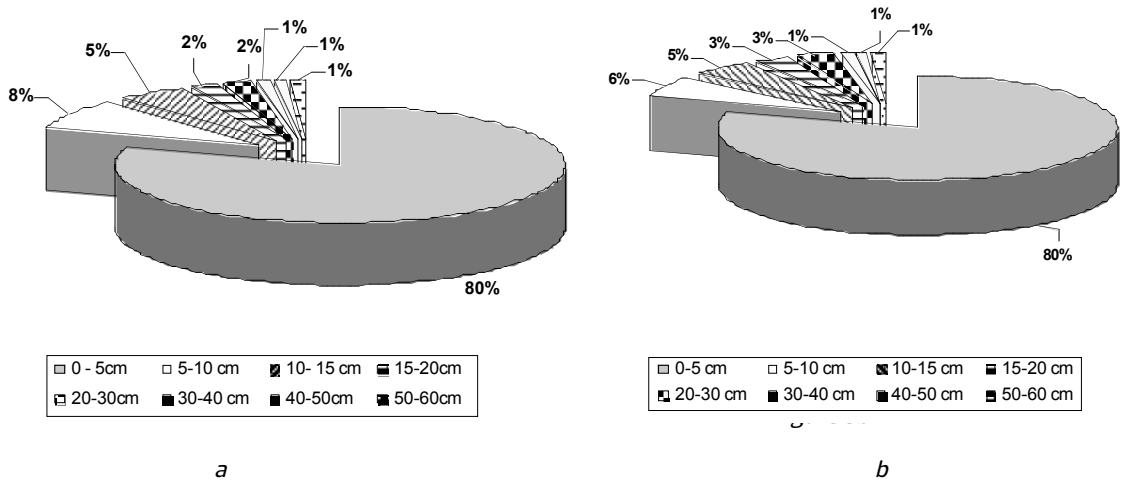
The experiment was conducted from August 2002 to August 2003. Six plots were filled to 15cm in depth and 60 cm with respectively gravel and soil. Three plots were planted with young shoots of *Phragmites australis* (36 stems/m^2), were taken from local and natural reed stand. Three unplanted plots served for checking. The soil (88% sand) used for the study is an alkaline basic soil (pH= 8.63). Wastewater used originates from an industrial tannery in the Marrakech region. The tannery effluent has an acid pH (3.08±1.16) and an important amount of total chromium (1230.5±123.2 mg/l) exceeding by far the maximal limit recommended by WHO (1989) guidelines (2 mg/l). The experimental plots were alimented by tannery wastewater, 3 times a week (10 litres per day). The water flowed vertically through substratum.

Results and discussion

TREATMENT OF TANNERY EFFLUENT BY PHYTOREMEDIATION

Total chromium in different soil horizons of the planted system

The total chromium undergoes an overall removal of 99 % for the two pilots, which provides limpid purified water (Tiglyene et al., 2005). The analytical results revealed that is a significant accumulation total Cr 80% in the surface horizon (0–5 cm) for planted (figure 1a) and unplanted systems (figure 1b); (Tiglyene et al., 2008a). Results also show that the Cr could migrate also towards deeper levels of the soil.



a *b*

Figure 1. Total chromium percent in different soil horizons of the planted and unplanted system

Total chromium content in *Phragmites australis*

Table (1) summarized that all parts of *Phragmites australis* contain chromium. Indeed, the Cr content presents a statistically significant difference ($p<0.01$) between leaves and roots of the plant.

Table 1. Total chromium content in Phragmites australis

	Leaves	Rhizomes	Roots
[Cr] g/Kg(dry weight)	0.25±0.5	0.35±1.5	6±0.5

Furthermore, after 13 months of experiment, the soil accumulates high content of chromium (94%) and 5% of Cr accumulated in *Phragmites australis.* The presence of plant ensures a sufficient porosity for the percolation of water for treatment, which makes it possible to treat a more important volume of wastewater and to reduce the required surface area by treated capita.

TREATMENT OF TANNERY EFFLUENT BY INFILTRATION PERCOLATION

The total chromium concentration at the inflow varies from 1009 mg/l to 1345 mg/l with an average concentration of 1230.5±123.2 mg/l. At the outflow, the total chromium concentration varies from 3.4 mg/l to 5 mg/l with an average concentration of 3±0.5 mg/l (Figure 2).

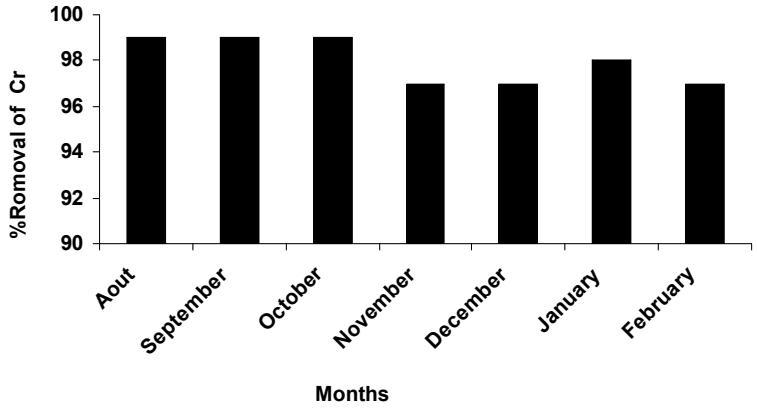


Figure 2. Temporal changes in total chromium at the inlet and outlet of system.

The total chromium contents at the outflow of the two systems are lower than the maximal limit recommended by WHO guidelines (2 mg/l). The total chromium undergoes an overall removal of 98% for the pilot, which provides limpid purified water (Tiglyene et al., 2008b).

Conclusions

Results indicated that the total chromium undergoes an overall removal of about 99% for the two pilots (planted and unplanted), which provides purified water. The results indicated also that there was a significant accumulation of total Cr reaching 80% in the surface strata for the planted system. *Phragmites australis* accumulated significantly high amount of Cr in the roots. After 13 months of experiment, the soil accumulates high content of chromium 94% and 5% of Cr accumulated in *Phragmites australis.* Furthermore, the presence of plant ensures a porosity sufficiency for the percolation of water in the treatment. Over seven months of experiment, the study of the treatment of raw tannery wastewater by infiltration percolation system showed that, the mean elimination rate for total chromium was 98%.This work shows clearly that the treatment of tannery effluent by reed bed combined with infiltration percolation system could be the depuration system alternative for raw tannery wastewater in comparison to the purely chemical approaches for the treatment of tannery effluents.

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