



Responses of *Typha latifolia* subjected to metal stress

Bensaid Marwa*, Meksem Amara Leila, Meksem Nabila, Ferfar Meriem, Djebbar Mohamed Reda

Laboratory of Cellular Toxicology, Department of Biology, Faculty of Sciences, University of Badji Mokhtar, Annaba, Algeria

Article published on June 23, 2017

Key words: Phyto-purification, Macrophyte, Metallic dusts, *Typha latifolia*, Oxydatif stress

Abstract

In order to preserve the quality of the waste water, we use the macrophyte plants, which go in the direction of the phyto-purification of an aquatic ecosystem. These purifying plants cleanse the water and transform the organic residues into nutritional elements from which they feed. They have a great ability to fix heavy metals. In our job, we orientated our study on the impact of metallic dusts rejected by the steel complex "Arcelor-Mittal" El Hadjar Annaba, on a macrophyte *Typha latifolia*. The sites of samples (S1, S2, S3, and S4) are located in the neighborhood of the steel complex, and the least polluted site (St) is located far from the sources of pollution. We studied several parameters: growth (medium number of roots), biochemical (content in protein at root level) and enzymatic (proportion of root catalase activity). We were also studying, the composition of metallic dusts rejected by the high stoves of complex Arcelor Mittal. Acquired results show an increase of parameters studied in the four sites of sample (S1, S2, S3, S4), compared with the site least polluted (St). Increase varies between significant ($p \leq 0.05$), and very highly significant ($p \leq 0.001$). These results explain the capacity of *Typha latifolia* to fit to the oxydatif stress generated by metallic dusts, *Typha latifolia* proves to be a very good bio-accumulator of heavy metals; we recorded a stimulation in growth, in content in proline and in activity catalase.

*Corresponding Author: Bensaid Marwa ✉ bensaidmarwa90@yahoo.fr

Introduction

The phyto-purification of water or use of vegetables for the treatment of wastewater and pluvial, is a recent technique which re-hangs the natural techniques of the phyto-purification. Effect cleaning up macrophytes is known in an empirical manner since for a long time however, it is only from 1950s that German researchers begin analysing this phenomenon in a scientific manner. They put in an obvious place that it is not plants themselves that have a cleaning activity, but rather microbes living around their rhizomes (underground stem in the form of roots). (Dabouineau *et al*, 2005).

Heavy metals are pollutants generated in most cases by human activity; they can be at the origin of several types of toxicity on the man, the animal and even vegetables. Their presence in environment and in most cases in water one of reason of the disturbance of the aquatic ecosystems. Certain plant kinds are known to be able to absorb the battery of pollutants and heavy metals, among which they find *Typha latifolia* «Club hammer with broad leaves» very used in the field of the phyto-purification of wastewater.

Pollution attained a threshold alarming level in Annaba, particularly in the neighbouring localities of the steel complex Arcelor-Mittal which is classified as a major pollutant of the region.

The objective of our work is to demonstrate the changes observed at the level of a purifying macrophyte of the waste water, in the event of industrial metals pollution. We aim to assess the impact of metallic dusts rejected by complex Arcelor-Mittal Annaba on *Typha latifolia*, on the one hand we will study several parameters of growth, biochemical and enzymatique. We will take a sample of samples from five sites (a site least polluted and four sites chosen according to the site of the source of pollution Arcelor-Mittal).

Materials and methods

The used plant equipment concerns a macrophyte *Typha latifolia* taken from five sites.

The sites of sample

So: the least polluted site, located at El Battah region of El kala.

S1, S2, S3, S4 are located in the neighborhood of the complex.

Samples were performed during the second quarter of year 2015.

One of analysed metallic dusts took a sample from the rejections of the high stoves of the complex Arcelor-Mittal HFx.

Proportion of metallic dusts rejected by the high stoves of the complex

Methods followed for the proportion of the different metallic elements of the complex, are studied and broadcast by the French Association of Normalization AFNOR. By using a spectrophotomètre of nuclear absorption of type ASX-520 Auto Sampler (AFNOR, 2016).

Table 1. The methods used for the proportion of metallic dusts.

Metallic dusts	Methods
Plomb/Zinc	NF ISO 8753
Cuivre	NF A20-427
Silice	Gravimetric dosage
Aluminum/Fer/Manganèse	Volumetric dosage

Medium Number of roots: This parameter is measured by the counting among roots of the plant after the collection of samples.

Content in proline at the level of the roots of *T. latifolia*: The technology of proportion of the used proline is that of Troll and Lindsley, (1955). (Meksem, 2016)

Proportion of the activity of catalase at the level of the roots of *T.latifolia*: Proportion spectrophotometrique

catalase activity (CAT) is accomplished according to the method of Cakmak and Horst (Boscoloa *et al.*, 2003).

We performed five repetitions for every studied parameter.

Statistical analysis

The statistical analysis of data is performed by the test T of Student which consists in comparing the averages of 2 sites with the aid of the data of two independent samples, it is accomplished with the aid of a software of analysis of data: Minitab (Version 16.0) (Dagnelie, 1999; Khaldi, 2014).

Results and discussion

Effects of metallic dusts on the medium number of the roots of Typha latifolia

The fig. 1 shows the variations of the medium number of the roots of *Typha latifolia* in the five sites of sample.

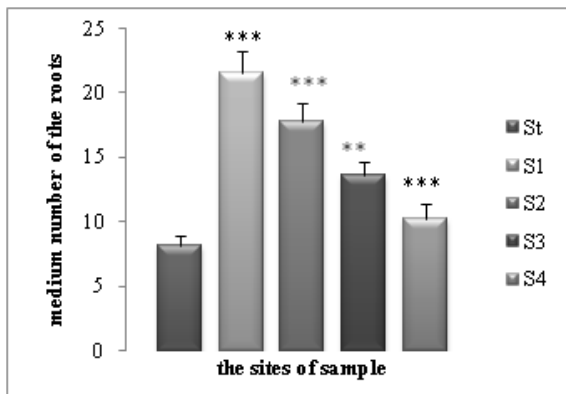


Fig. 1. The medium number of the roots of *Typha latifolia* in the five sites of sample.

We determine a very highly significant increase ($p=0.000$) of the medium number of the roots of *T.latifolia*, between the least polluted site St and sites (S1, S2 and S4) with one. We also determine

Content in proline at the level of the roots of Typha latifolia

The figure 02: illustrates the variations of content in proline at the level of the roots of *T.latifolia* in the five sites of sample (mg/g MF)

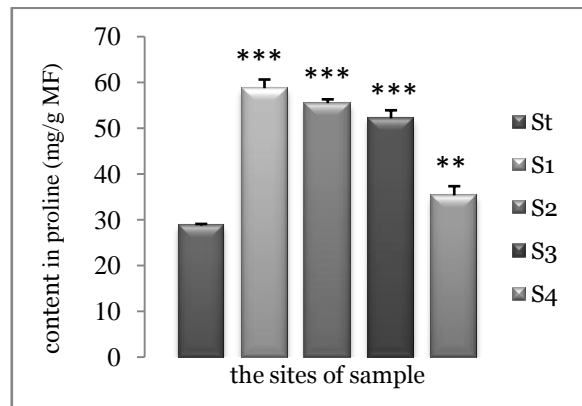


Fig. 2. Proline content (mg/g) at the level of the roots of *Typha latifolia* in the five sites of sample.

The results obtained, show that the content of proline racinaire, is higher in the four polluted sites, compared to the site less polluted. This difference is very highly significant ($p=0.000$) between St and the sites (S1, S2 and S3), and highly significant ($p=0.003$) between St and S4.

difference significant ($p=0.02$) in S3 compared with the St.

Table 2. Percentage of the rejections of the high stoves of complex Arcellor-Mittal.

Metallic dusts	mg/l	Algerian norms
Fe	18.53	3
Al	3.42	3
Mn	1.05	1
Cu	0.03	0.5
Zn	7	3
Pb	0.8	0.5

Proportion of activity Catalase at the level of the roots of Typha latifolia

The figure 03: shows the variations of catalase activity at the level of the roots of *Typha latifolia* (nmol/min/mg of protein) in the five sites of sample

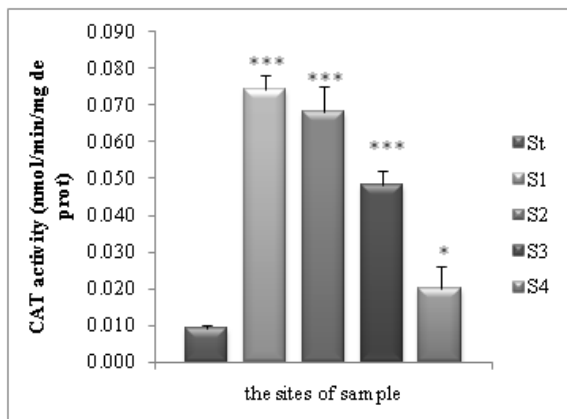


Fig. 3. Variations of catalase activity at the level of the roots of *Typha latifolia* (nmol/min/mg of protein)

We recorded an increase CAT activity of roots, in the four polluted sites (S1, S2, S3 and S4), compared to the site less polluted St.

This difference is very highly significant (p=0.000) between the sites (S1, S2 et S3) and St And it is significant (p=0.027) between S3 and St.

The analysis of the composition of the metal dusts, rejected by the high stoves of the complex Arcellor-Mittal (table 2), has shown an increase in the concentration of elements analyzed by contribution to the Algerian standards of industrial discharges (JORA, 2006). The results obtained in our research,

show that this pollution, stimulates the average number of roots, the proline content and root the catalase activity of roots of *T.latifolia* in neighboring regions. In our job, we put in evidence a root system more developed to taken *T.latifolia* polluted middleand particularly in S1 near complex Arcellor-Mittal compared with samples taken has leave the site least polluted. These results are similar to those of (Esser,1999), which translates the increase among the roots of reeds due to the fact that reeds have a very active root system, and are able of resisting to the most dangerous xénobiotiques such as heavy metals, detergents and pesticides.(Moffat *et al.*, 2001) stipulate that plants used for the phytoepuration have a quick growth.

Sandermann (1994) adds that for the mechanisms of phyto-dépollution, in general, plants having a system broad and root dense are favored because they on tune bigger absorbency and they explore a vaster zone of soil.

The proline is an amino acid known for its accumulation in a big variety of organisms since baking yeast up to plants the upper, displayed in a stress abiotique (Pardhaet *al.*,1993), such as stress leads by heavy metals (Alia and Pardha, 1991), (Trpathi *etal.*, 2006), by manures (Deruelle, 1983) and by a fungicide (Meksem, 2007).

Concerning the increase of content in proline leaf to *T.latifolia* in the four sites by provision to the witness, our results compound with those of (Bensoltane, 2006) which recorded an increase of the proline during a stress of in NH₄NO₃ to ship's apprentices and lichens.

Several researches mentioned that the increase of content in proline translates the stress of the plant procreated by the accumulation of a pollutant (Deruelle, 1983);(Legadic *et al.*, 1997); Hellmann *et al.*, 2010).

An increase of content in proline to *Lemna minor* and *Elodéa canadensis* in the presence of Calliofop 36 EC (Tlidjen, 2014), (Kleche, 2013) recorded also an increase of content in proline to *Phragmites australis*.

These results can confirm our results as regards adaptation of *T. latifolia* on the conditions of stress. The proline can play an inhibitive role of heavy metals according to (Ferago and Mullen, 1979).

The catalase is one of the antioxidizing most efficient enzymes according to (Khaldi, 2014).

They determined an increase of catalase activity in four sites by provision in the site witness. The most well brought up rate is recorded in S1 near complex Arcellor-Mittal,

These results compound with those of (Meksem, 2007) which worked on a variety of hard wheat *Triticum durum* subjected to two fungicides flamenco SC and Tilt 250 EC, and that put in an obvious place an increase of catalase activity. The entirety of enzymes implicated in the détoxification of ROS, introduces a net increase of activity.

Conclusion

Typha latifolia is a plant present in the littoral zone of lakes and other shallow waters in temperate climates. Our study can demonstrate its ability to grow in polluted environments without severe physiological disturbance.

The results obtained in our study, revealed that the steel complex Arcellor-Mittal exercises a very high pollution of waters, the surrounding regions. *T. latifolia* is very sensitive in the presence of pollutants (the metal dusts) in its environment. *T. latifolia* has proved to be a very good bio-accumulatrice metal dust.

There has been an increase in the average number of roots, in the proline content and root in the catalase activity at the level of the roots, in the four sites polluted by contribution to the site less polluted. The highest figures were recorded at the level of the site S1 near the complex Arcellor-Mittal

References

Alia P, Pardha S. 1991. "Proline accumulation under heavy metal stress", Journal of Plant Physiology, **138**, 554-558.

Association Française de Normalisation : NF A20-427 aout 1985. "Dosage du cuivre": laboratoire centrale du complexe Arcellor-Mittal. janvier 2016.

Association Française de Normalisation, NF ISO 8753. 1987. "Dosage du plomb et du zinc": laboratoire centrale du complexe Arcellor-Mittal. janvier 2016.

Bensoltane S. 2006." Evaluation de la toxicité du nitrate d'ammonium (NH₄NO₃) sur différents modèles biologiques: Mammifères, Végétaux, et Protistes ciliés". Thèse de doctorat d'état en Eco toxicologie Animale. Université d'Annaba. 153p.

Boscoloa PRS, Menossi M, Jorge RA. 2003. Aluminum-induced oxidative stress in maize, Journal of Phytochemistry, **62**, 181-189.

Dabouineau L, Lamy Y, Collas Ph. 2005. "Phytoremédiation et phytoépuration ou l'utilisation des plantes pour la dépollution et l'épuration des eaux usées".

Deruelle S. 1983."Écologie des lichens du bassin parisien. Impact de la pollution atmosphérique et relation avec les facteurs climatiques". Thèse de doctorat: Université Pierre et Marie Curie, Paris (France).

Esser D.1999. "Les phragmifiltres". Journée d'information technique «les filtres plantés de roseaux ».Metz. 8 avril 1999. Agence de l'eau Rhin-meuse.

- Farago ME, Mullen WA.**1979. "Plants which accumulate metals". Part IV. A possible copper-proline complexe from the roots of *Armira maritime*. *Inorganica Chimica Acta*; **32**, 93-94.
- Hellmann H, Funck, D Rentsch D, FrommerWB.** 2006. "Hypersensitivity of an *Arabidopsis* sugar signalingmut toward exogenous proline application".*Journal of Plant Physiology* **16(2)**, 149-158.
- Khalidi F.**2014. "Mécanismes d'action des polluants chimiques industriels (Engrais et NOx) sur des bio-indicateurs de pollution (Mousses et Lichens). Thèse de doctorat d'état.
- Kleche M.** 2013. "Utilisation des systèmes biologiques dans l'épuration des eaux usées cas de la région d'Annaba". Thèse de doctorat d'état. Université Badji Mokhtar Annaba.
- Journal Officielle de la République Algérienne. JORA.** 2006. N°26.Laboratoire centrale du complexe Arcellor-Mittal. "Dosage Gravimétrique de la silice/dosage Volumétrique du fer, Manganèse Uminium" .2016.
- Lagadic L, Caquet T, Amiard JC, Ramade F.**1997. "Biomarqueurs en écotoxicologie. Aspects fondamentaux". Paris: Masson.
- Meksem Amara L.** 2007."Etude des effets de deux fongicides: le Flamenco SC et le TILIT250 EC sur la physiologie, la croissance et le métabolismeénergétique des racines de *Triticum durum*DESF: variétés GTA et VITRON". Thèse de Doctorat d'état. Université Badji Mokhtar Annaba
- Moffat AJ, Armstrong AT, Ockleston J.** 2001. "The optimization of sewage sludge and effluent disposal on energy crops of short rotation hybrid poplar".*Journal of Biomass and Bioenergy* **20**, 161-169.
- Pardha S, Alia P, VaniB.** 1993. "Inhibition of mitochondrial electron transport is the prime cause behind proline accumulation during mineral deficiency in *Oryzasativa*". *Journal of Plant and Soil*: **155/156**,465-468.
- Sandermann H.**1994."Higher plant metabolism of xenobiotics; the green liver. *Concept Pharmacogenetics.* **4(5)**, 225-41.
- Tlidjen S.** 2014. "Impact de xénobiotiques, sur une végétation aquatique, épuratrice des eaux usées: biométrie, aspect biochimique,enzymatique, métabolisme énergétique et cytotoxicité".Thèse de doctorat d'état, université Badji Mokhtar Annaba p 70.
- Tripathi BN, MehtaSK, Anshu A, Gaur JP.**2006."Oxidative stress in *Scenedesmus* sp.During short and long-term exposure to Cu²⁺ and Zn²⁺", *journal of Chemosphere* **62(4)**, 538-44.