Purification Of Different Types Of Waters In The Region Of Tiaret (Algeria) By Biological And Physical Methods

Yamina Omar [1], Djamila Mehdeb [2], Mohamed Amine Bezzerrouk [3], Walid Dahmani [1], Fatiha Chalane [4], Ammam Abdelkader [5], Belmamoun Ahmed Reda [6]

[1]Laboratory of agro-biotechnology and nutrition in semi-arid areas. Faculty of Life and Natural Sciences, University of Tiaret, Department of Ecology and Environment and Biotechnoly, 14000, Tiaret, Algeria.

[2]Biotechnology applied laboratory to agriculture and environmental preservation, Higher School of Agronomy, Mostaganem, 27000, Algerie.

[3] Laboratory of Industrial Technologies, Faculty of Applied Sciences, University of Tiaret, 14000, Tiaret, Algeria.

[4]Dr. Moulay Tahar, University of Saida, 20000, Algeria

[5] Department of biology, Faculty of Sciences, University Dr Moulay Tahar, Saida, Algeria.

[6] Department of agronomy , Faculty of Natural and Life Sciences , University of Djillali Eliabes ; Sidi-Bel - Abbes; Algeria.

*Corresponding authors: yamina.omar@univ-tiaret.dz

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Abstract

The considerable development of agricultural and industrial activity has led to the emergence of new classes of organic pollutants say "persistent" which are resistant to the processes of conventional treatment of the waters.

Among the most recent progress, based on the techniques of advanced oxidation, photocatalysis represents of our days, an emerging solution to the problems of pollution of groundwater environments, because that can degrade organic matter in basic products and be less toxic. This technique associated with a biological method "bio-monitoring" allows you to purify the waters effectively, simply, and less costly.

Our results show Lemna minor accumulates well lead and zinc in the different waters, these levels oscillate an average of 25.00 ± 5,00µg/g at 80,00 ± 29,17µg/g and 575,76 ± 367,74µg/g to 18.00 ± 4,33µg/g respectively for the lead and zinc. The use of the photocatalytic process in the presence and absence of photocatalyst SnO2 and the aquatic plant Lemna minor under visible light found that the absorbance decreases compared to the initial state which confirms that this method is reliable for the purification of water.

Keywords: Photocatalytic process, Lemna minor, SnO_2, Tiaret, lead, zinc.

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1. Introduction

The pollution of the water is an alteration of its quality and its nature which makes its use dangerous and/or disrupts the aquatic ecosystem. It may concern surface waters and groundwater. It has main origins, in human activity, industries, agriculture, and the discharge of industrial and household waste [1].

Currently, research is moving to the means of bio-monitoring of the effects of the pollutants emitted by landfills in the water, the soil, the atmosphere, and the surrounding ecosystems.

Among the monitoring tools appear in a good place the bio-indicators informing on the overall quality of the environment, among which we can mention the biological index standardized global (IBGN) or the diatomic index (IBD) [2], and plants bio-indicators of accumulation such as bryophytes and algae [3];[4].

The use of these plants is particularly interesting because, thanks to their large capacities of accumulation, these plants have the advantage of being able to track, outside of phytotoxic effects, pollutants whose main characteristics are often their fugacity modeling (accidental pollution) and/or of the levels hardly detectable in the main vector of pollution, water [3]. The development of Bio-indication thus opens the way to broader surveillance and integrating ecological effects on the environment through the organization's sentinels. [5];[4];[6].

In addition to Bio-monitoring, photocatalysis appears as a technique of choice for this type of application. It allows, in effect leads to the complete oxidation of most of the organic pollutants at ambient temperature and atmospheric pressure.

The present study is devoted to studying the employment and opportunities for the detection of plant bio-indicators of accumulation of heavy metals, by the use of aquatic plants installed directly in different types of waters, on the one hand, on the other hand, considering the efficiency of a process photocatalytic by the use of a photocatalyst semi driver such as the carbon dioxide of tin (SnO2) to treat and purify the water.

2. Materials And Methods

2.1. Experimental device

In this experimental study, we used two methods to achieve the desired objectives. In the first place, we installed a plant in the bio-station, it is the lens of water (Lemna minor). This plant has been chosen because of its small size, its simple structure, its rapid multiplication, and its broad geographic distribution [7]; [8]; [9]; [10].

The choice of sentinel plants has been guided by their power of accumulation and by their ability to withstand these waters. These plants have been completely immersed in the water.

These plants are part of aquatic plants generally used for the treatment of residual waters domestic or industrial The fact of their performance in the elimination of carbonaceous pollution and their capacity of assimilation of nitrogen or phosphorus [6].

Then we integrated photocatalysis which is a physical method, based on the exposure of water to the radiation of visible light using a halogen lamp (solar spectrum), under the presence of a photocatalyst the SnO2.

This method has for aims, on the one hand, to decompose certain polluting substances present in the water, which are harmful to human health, to transform them into oxidized compounds (carbon dioxide and water, for example), and disinfect the water, on the other hand, the elimination of a large part of pathogenic micro-organisms of this last [11] ; [12].

During this study, we used three types of water: water from the dam Dahmouni, wastewater, and the water source of Sabaine.

2.2. Experimental device for the photocatalysis

The experimental device is composed of a room equipped with a halogen bulb to simulate the solar spectrum and five beakers bearing the five types of water. The lamp is cooled by a fan to avoid the factor of temperature on our samples (Fig.No. 1). Levy and dosage of elements (Pb, Zn)The levies to the water have been carried out, for 03 months in reason of two times per week. After each sampling, the determination of the levels of trace elements metal (Pb, Zn) in the plant has been done.The water brought from different sites has suffered differential treatment to be able to determine the levels of trace elements of metal. In effect at the laboratory the steps followed are the following [13]:- It Adds 5ml of nitric acid to 100ml of the sample and then we proceeded to have evaporation of up to 15ml. Then add 2ml HNO_3 and 1ml H_2O_2 and we proceed has an evaporation of up to 5ml.- After we proceeded to the filtration of our samples. The tubes are supplemented with 100 ml of distilled water. The samples are collected at the beginning of the experiment.The samples of the plant collected have been placed in plastic bags, and their arrived at the laboratory, these species have been rinsed with distilled water and then dried and crushed following the protocol defined by [14]:

- Dehydration of plants: the usual method is dehydration in the oven at 105°±2°C for 72 hours. The dehydrated samples were weighed to weigh dry matter MS, which is of the order of 0.2 to 0.3 g per time 1g.

- Grinding: This step is highly critical because it can be a source of contamination or loss. For plants, the chopper used is a mortar in the agate. The materials constituting the chopper are composed of titanium, guaranteed steels without "Heavy metals". The powder obtained is calcined in a furnace in capsules of quartz whose temperature is increased gradually up to 500°C.

- Mineralization and placing in solution: the fine powder obtained, after calcination, is placed in an acid solution and oxidative (mixture of nitric acid HNO_3, the hydrofluoric acid, and perchloric acid ClHO4) and then heated in a bain-marie, up to the complete destruction of the organic matter. After we proceeded to the filtration of our samples. The tubes are supplemented with 10 ml of distilled water. This method allows the determination of the whole of the element's metal traces.

The determination of lead, zinc, and copper is carried out by atomic absorption spectrometry in the mode of electrothermal atomization Spectrometer (Perkin Elmer 100).

3. Results And Discussion

Study of the variability of concentrations of trace elements contents metal in Lemna minor and the different waters

The whole of the results which summarizes the different concentrations of trace elements metal (Pb, Zn) in the different waters, which is the subject of this study are illustrated in the table below.

TABLE 1 Descriptive Statistics on the concentrations of trace elements metal (µg/g) in the different waters as well as in Lemna minor

Waters Dahmouni Dam	Initial concentration (n= 25)	Pb (µg/g)	Zn (µg/g)
		10.00 ± 2.60	12.00 ± 3.84
	Final concentration	4.00 ± 1.15	2.00 ± 0.26
Lemna minor + Waters Dahmouni Dam	Initial concentration (n= 25)	12.00 ± 4.00	10.00 ± 3.18
	Final concentration	40.00 ± 12.97	40.00 ± 12.88

Wastewater	Initial concentration (n= 25)	42,30 ± 11.28	240,00 ± 137,84
	Final concentration	6.00 ± 2.97	20.00 ± 9.88
Lemnaminor + Wastewater	Initial concentration (n= 25)	12.00 ± 7.23	8.00 ± 5.97
	Final concentration	80,00 ± 29.17	575,76 ± 367,74
Sebaine water	Initial concentration (n= 25)	6.00 ± 2.00	7.00 ± 2.54
	Final concentration	2.00 ± 0.96	3.00 ± 1.76
Lemnaminor + Sebaine water	Initial concentration (n= 25)	12.00 ± 7.00	8.00 ± 4.97
	Final concentration	25.00 ± 5.00	18,00 ± 4.33

The review of table no. 1 allows you to see a very high accumulation of zinc in Lemna minor diving with wastewater with an average of 575,76 ± 367,74 µg/g. We perceive, also, a high accumulation of zinc with Lemna minor in the waters of Dahmouni dam with an average of 40,00 ± 12.88 µg/g. The lowest levels are saved with Lemna minor in the waters of Sebaine sources with an average of 18.00 ± 4.33 µg/g.

We observe a low variability of the levels of lead with Lemna minor between the different waters, these levels oscillate an average of 25.00 ± 5.00 µg/g at 80,00 ± 29.17 µg/g.

We note a net decrease in the levels of lead and zinc in the different waters, indeed, for the waters of the dam Dahmouni the rate of lead is past 10 µg/g to 4 µg/g and 12 µg/g to 2 µg/g for zinc. The levels of wastewater are increased from 42,30 ± 11.28 µg/g to 6.00 ± 2.97 µg/g and 240,00 ± 137,84 µg/g to 20.00 ± 9.88 µg/g, respectively for the lead and zinc. On the other hand, we distinguish that the lowest levels are saved with the waters of Sebaine sources, In effect, the levels of lead and zinc in the past are respectively 6.00 ± 2.00 µg/g to 2.00 ± 0.96 µg/g and 7.00 ± 2.54 µg/g 3.00 ± 1.76 µg/g.

This decrease can be explained only by the fact that Lemna minor accumulated in these tissues the lead and zinc from the water, since the levels of lead are passed of 10.00 ± 2.60 µg/g to 4.00 ± 1.15 µg/g and 42,30 ± 11.28 µg/g to 6.00 ± 2.97 µg/g, respectively for the waters of the dam Dahmouni and wastewater.

The concentrations of Pb and Zn in wastewater and the waters of the dam Dahmouni, far exceed the recommended maximum for the treated wastewater for irrigation purposes (irrigation in continuous and for any type of soil), which is 5mg/1, and 2mg/L respectively [15].

The results obtained could we indicate a high level of contamination of the water of the dam dahmouni by these toxic metals since the waters of rejection are discharged directly into the dam which is intended for the irrigation of thousands of agricultural land. Indeed [9], has reported that the waters of the rejection of the sewage plant in Tiaret are contaminated by Pb, Zn, and Cu.

[16] declare that the heavy metals typically found in wastewater are Cu, Zn, Pb, Cd, and Fe. These micro-pollutants are derived from domestic wastewater or industrial waters, as well as automobile traffic emits fine metallic particles into the atmosphere primarily in urban areas which are deposited on the soil and however can achieve the sanitation networks by runoff to the course of events rainy [17].

Variation of the absorbance of the light as a function of time of the photocatalysis without and with the lens of waters for different waters

A- The water of the dam Dahmouni

Figure No. 1 refers to the absorbance of the visible light by the water of the dam without and with a treatment by the photocatalysis, on the one hand, and in combination with the water lens, on the other hand, to see the influence of the light and the photocatalyst on the performance of the accumulation of pollutants by the plant. Distilled water is used as a reference in this study. The region of the visible spectrum chosen is between 900 nm to 1050 Nm.

We note that clearly, the absorbance of the initial state is practically large compared to the other. This means that there is a change at the microscopic level solutions. By elsewhere comparing the absorbance of the samples, treated by the photocatalysis, only and with the lens of water, we can see the decrease of the absorbance of the sample fitted with the plant compared to the sample nu for the same duration (1 hour and 2 hours), this decrease of the absorbance confirms the improvement in the performance of the Purification of this type of water by mixing the photocatalyst with the lens of water.

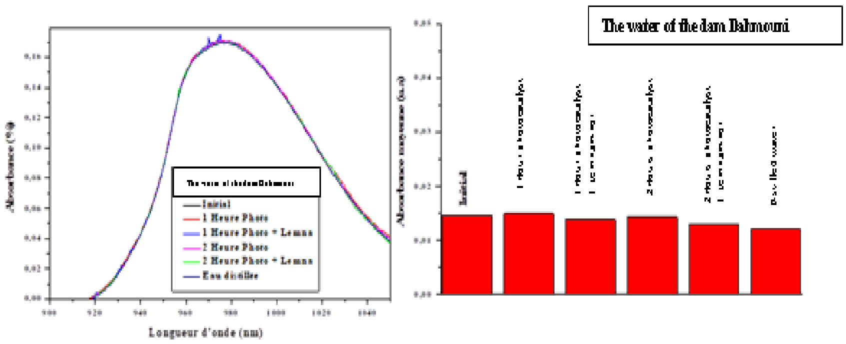

Figure 1: The absorbance and the absorbance average of the visible light by the water of the dam

B- The water treatment station (wastewater)

We note for the water worn, an extraordinary phenomenon, in effect, we find that the absorbance of the initial state is very high compared to other states.

For 1 hour and 2 hours of photocatalysis (with and without the lens of water), the absorbance is less compared to that of the sample with the lens of water, this phenomenon can be explained by the combination of oxido-reduction that gives birth to elements free (pollutants not related to water molecules) which are considered as obstacles in front of the transmission of the light.

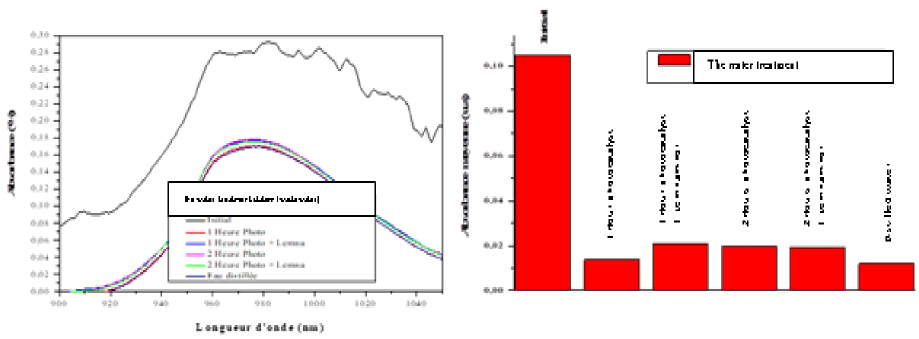

Figure 2: The absorbance and the absorbance average of the visible light by the wastewater.

C- the source water of Sebaine

The variation of the absorbance, for the source water sebaine, is very low (Fig. No. 3), this can be explained by the fact that this water is safe for drinking, therefore it is logical. The same phenomenon is noticed earlier for the increase of the absorbance using the plant, which encourages us to continue in this research by increasing the duration of treatment to follow the evolution of the variations of the absorbance without and with the lens of water.

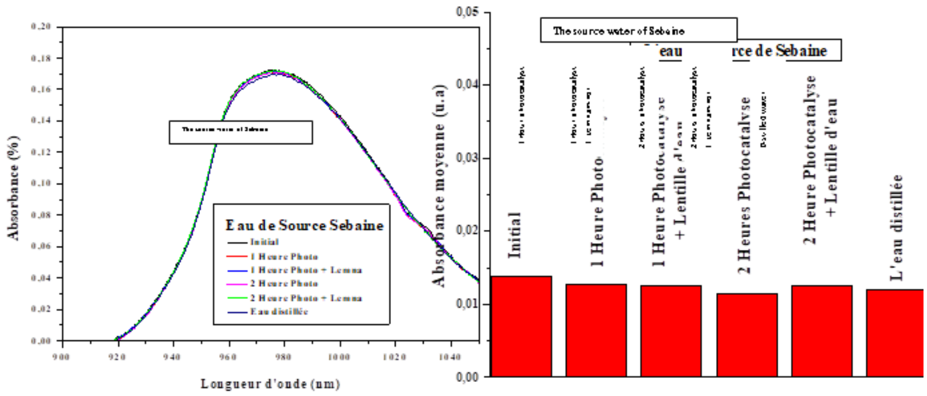

Figure 3: The absorbance and the absorbance average of the visible light by the water of Sebaine.

Conclusion

The purification of water is part of a large interest of many countries in the world, on the one hand for the drinking water, on the other hand for the decontamination and disinfection of liquid waste industrial and urban and loaded with chemical pollutants and bacteriological which constitute a risk for the beings living in general and human health precisely. This work was to assess two techniques, photo-heterogeneous catalysis, and bio-monitoring as an alternative to the traditional treatments of the water for the degradation of trace elements and the destruction of microorganisms. The lens of water (Lemna minor), was chosen to study the possibility of purification of the different types of water: the water of the dam Dahmouni, water-worn, and the water of sebaine, in parallel we used a physical method called "photocatalysis " to purify these waters.

For the first time, we are interested in the accumulation of trace elements the Zn and Pb by the biological method of "The Bio-monitoring" by the use of the Aquatic Plant Lemna minor ;

A second time, we studied the photocatalytic degradation in the presence and absence of photocatalyst SnO2 and the aquatic plant Lemna minor under visible light. Where we have found that the absorbance decreases compared to the initial state which confirms that this method is reliable for the purification of water. It is concluded that the assimilation of the lens of water and the photocatalyst in the course of treatment photocatalytic has an important role in the purification of water.

This work is far from being completed since these results are highly motivating to do other experimental protocols to improve the technique of water treatment and increase the performance of the Purification para.

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