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Biological degradation of Loratadine

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Abstract

The production and use of a large number of chemical substances, in particular those which have a biological activity, cause their accumulation in the effluents leaving the production sites and thus in the environment. Aquatic environments are among the most exposed. Several studies show that all drug families or diagnostic products could be detected in the aquatic environment: Antihistamines, Corticosteroids, Antibiotics, NSAIDs, hormones etc ... to name but a few. To combat this pollution, various effluent decontamination techniques such as biological degradation are being researched and developed. The aim of this work is the use of an activated sludge biological process to degrade an antihistamine drug, the Loratadine. The physicochemical parameters analyzed, such as: pH, turbidity, COD, BOD_5, biodegradability ratio, NO_2^- and the aromaticity of the organic matter show that the biological activated sludge process is suitable for the treatment of Loratadine at low concentrations

1. Introduction

Nowdays, ecology and the environment are topical subjects and are attracting more and more the scientific and public community. As a result of improved medical care, longer life expectancy and progressive industrialization, the amount of medicines consumed has increased. However, in many cases these products are not fully absorbed and metabolized by the patient but are partially excreted.
As a result, traces of these products rejoin the water cycle [1-3].
The objective of this work is to study the degradation of a pharmaceutical product the Loratadine by biological route to activated sludge.

2. Materials and methods

A 5-liter maximum cylindrical-conical test pilot was performed for biological treatment tests.
All the manipulations were carried out with volumes of one liter of activated sludge and two liters of waste water. The supply of oxygen is provided by an air pump.
The purification tests were carried out over a period of 5 hours. Pollution parameters such as pH were analyzed using a pH meter, turbidity with a turbidimeter, BOD5 is measured by a BOD meter where the sample is allowed to incubate for 5 Day at 20 ° C and COD by COD where the oxidation of the organic matter is carried out by potassium dichromate in an acid medium and in the presence of a catalyst in a temperature range of 140-150 °c.Chlorine and NO_2^- were analyzed by the colorimetric method [4].The surface tension was measured by the stalagmometer method. The biodegradability report (k) is defined as:

$$K = \frac{COD}{BOD5}$$

The aromatic degree (SUVA) is defined by the following formula: SUVA = A254 / COD in $cm^{-1}.g^{-1}$ L For the measurement of suspended solids (TSS), the drying method at 105 ° C for 24 hours was followed. The temperature of the water during the tests is in the region of 20 ± 2 ° C.
The drug studied is Loratadine, an antihistamine with a molecular weight of 382.883 g and a chemical formula $C_{22}H_{74}ClN_2O_2$. The concentrations used are 1; 2.50 and 5 mg / L.
The experiments were carried out in the aerated pilot reactor in the presence of various concentrations of Loratadine added to the wastewater.

3. Results and discussion

3.1. Hydrogen potential

Variations in pH during biological treatment of Loratadine are shown in Figure 1.

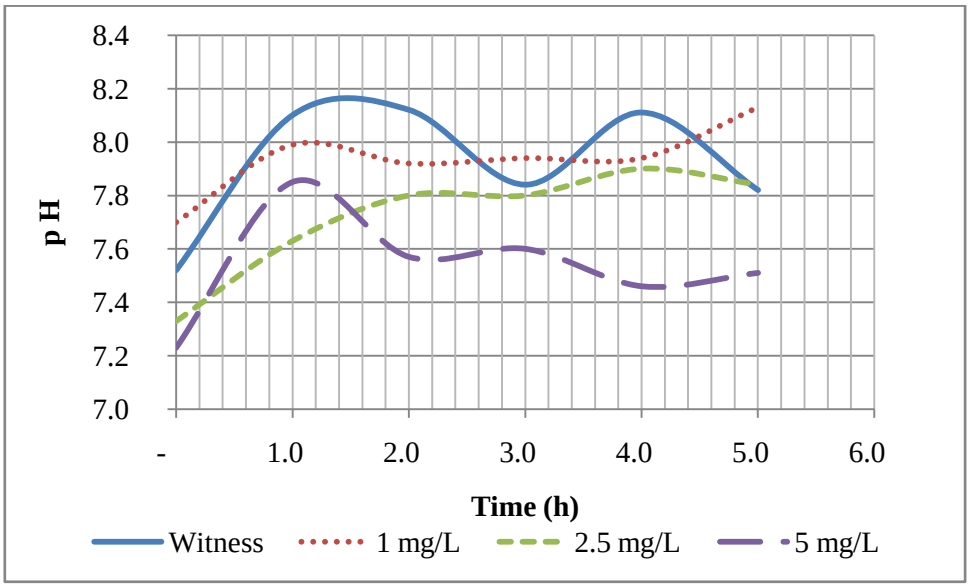

Figure 1: Evolution of pH during treatment as a function of Loratadine concentrations.

At the beginning of the treatment, at t equal to 0, the pH of the solutions is between 7.2 and 7.7.
After the addition of Loratadine, the pH increases for the three solutions and after one hour of treatment a decrease is observed to t equal to 4 hours for concentrations of 1 and 5mg / L. An increase is observed for the concentration of 2.5mg / L until t equal to 4h and after 4 hours of treatment the pH decreases. On the other hand, it increases for concentrations of 1 and 5mg / L. The pH oscillates between 7.2 and 8.4 whatever the concentration of drug studied. The increase in pH is may be partly due to volatilization of acid compound or dissolved CO_2 [5].
The decrease in pH was observed in the degradation of ten pharmaceutical compounds (acid clofibric, ibuprofen, gemfibrozil, fenoprofen, ketoprofen, naproxen, diclofenac, indomethacin, propyphenazone and carbamazepine) in a membrane bioreactor immersed [6]. A substantial elimination of acidic pharmaceuticals was obtained under pH conditions (pH <7.5) [7-8], because in these conditions, these pharmaceuticals are not ionized and increase their hydrophobicity, which increases the tendency to adsorption of these substances on biomass.

3.2 Turbidity

Variations in turbidity during biological treatment of Loratadine are shown in Figure 2.

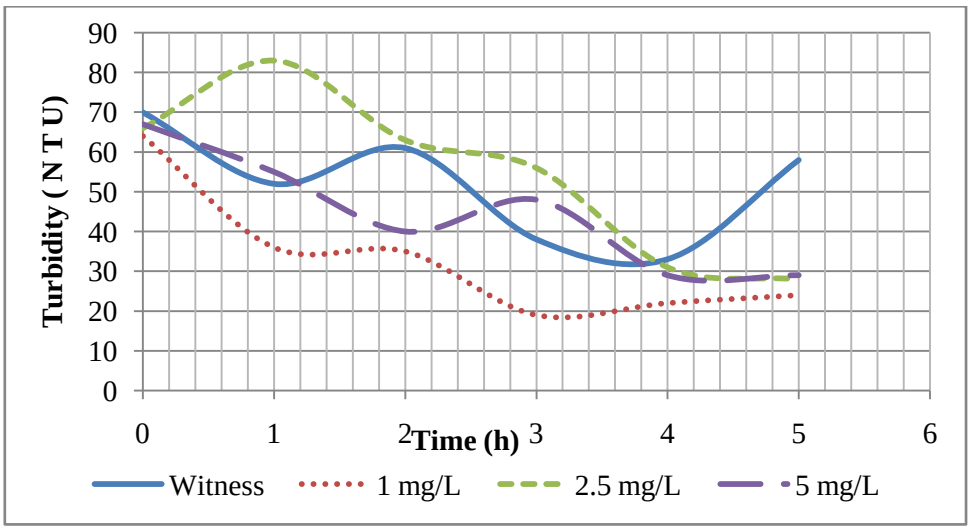

Figure 2: Evolution of turbidity during treatment as a function of Loratadine concentrations.

We observed that the turbidity decreases until the end of the treatment for the concentrations of 1; 2.5 and 5mg/L, respectively from 62. 64 and 70 NTU to 22.24 and 30 NTU .

Whatever the concentration used, the turbidity decreases until the end of treatment.

The turbidity is above that of control for the concentration of 1 and 5 mg / L and is below that of control for the concentration of 2.5 mg / L.

The decrease in turbidity indicates the presence of colloidal particles in water, due to strong structural changes of the materials in suspension or by chemical reactions with strong impact on the latter, such as polymer hydrolyzed or organic components and thus the lysis of bacteria.

3.3 Chemical oxygen demand

Variations in COD during biological treatment of Loratadine are shown in Figure 3.

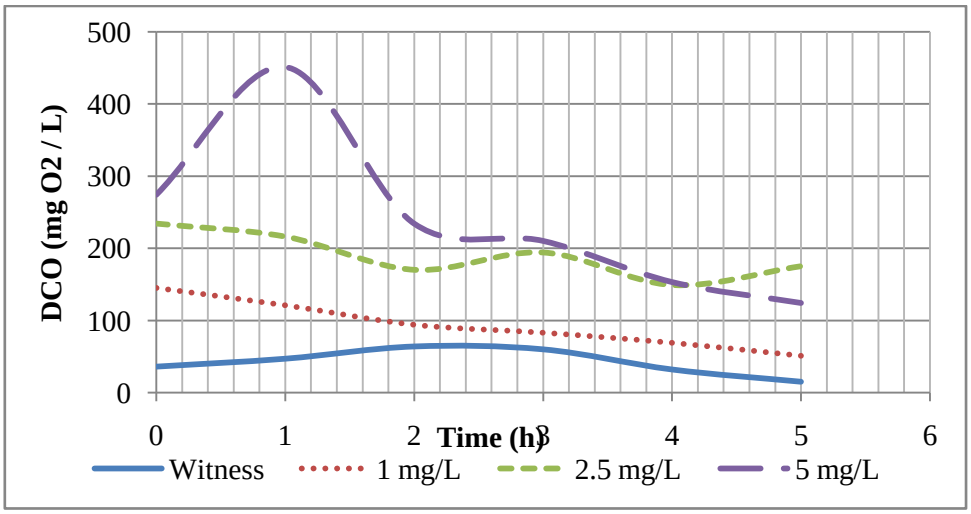

Figure 3: Evolution of COD during treatment as a function of Loratadine concentrations.

After the addition of Loratadine, COD decreases progressively during treatment, the COD is above that of the control for all Loratadine concentrations. COD decreases during treatment for the control test up to 80%.

COD decreases progressively during treatment. During the biological treatment the COD decreases to zero t of 148.186 and 316 mg O2 / L respectively at 66.115 and 87mg O2 / L until the time of 5 hours for the concentrations of 1, 50 and 100mg / L.

The decrease of the COD after the addition of drugs can be explained by the phenomenon of adsorption and the interactions between the drugs and the TSS [9-10] which leads to their sedimentation to the flocculation which poses the problem of availability of organic compounds.

3.4 *Biological oxygen demand*

BOD_5 is measured before and after treatment only. The results of this parameter are shown in the following graph.

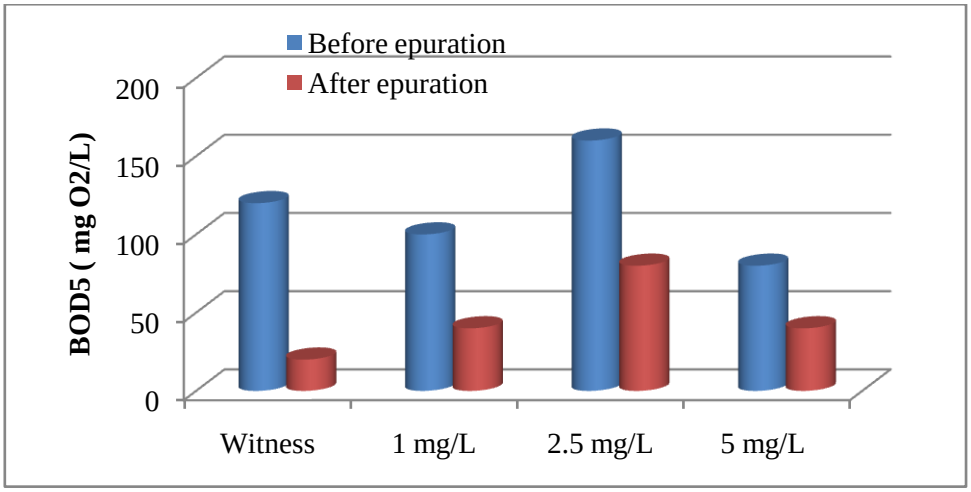

Figure 4: Evolution of BOD_5 during treatment as a function of Loratadine concentrations.

After drugs addition, BOD_5 decreases for Loratadine concentrations of 1 and 5 mg / L. It increases for the concentration of 2.5 mg / L. The decrease in BOD_5 is due to a toxic effect of the drugs in this study on the microorganisms present in the wastewater [11].

3.5 Biodegradability ratio

The variations in biodegradability ratio (k) during biological treatment are shown in Figure 5.

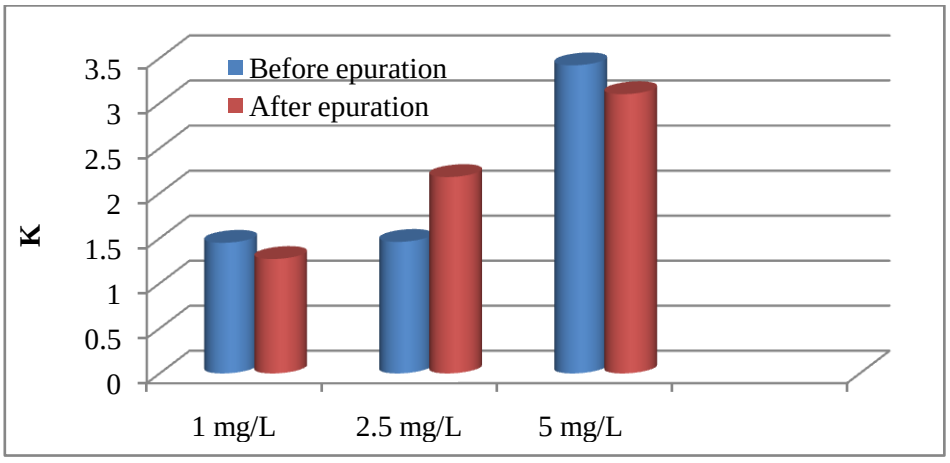

Figure 5: Evolution of the biodegradability ratio during treatment as a function of Loratadine concentrations.

After the purification, the biodegradability ratio decreases for the control test, which confirms that the products resulting from the degradation are still readily biodegradable.
The COD / BOD_5 ratio is less than 3 for both trials containing Loratadine at 1 and 2.5 mg / L, so the effluent is readily biodegradable, whereas that at 5 mg / L is moderately biodegradable because its biodegradability index is greater than 3.Concerning the ratio of biodegradability, its results show that the drugs studied are easily biodegradable.

3.6 Nitrites ions

The variations of NO_2^- ions during biological treatment of Loratadine are shown in Figure 6.

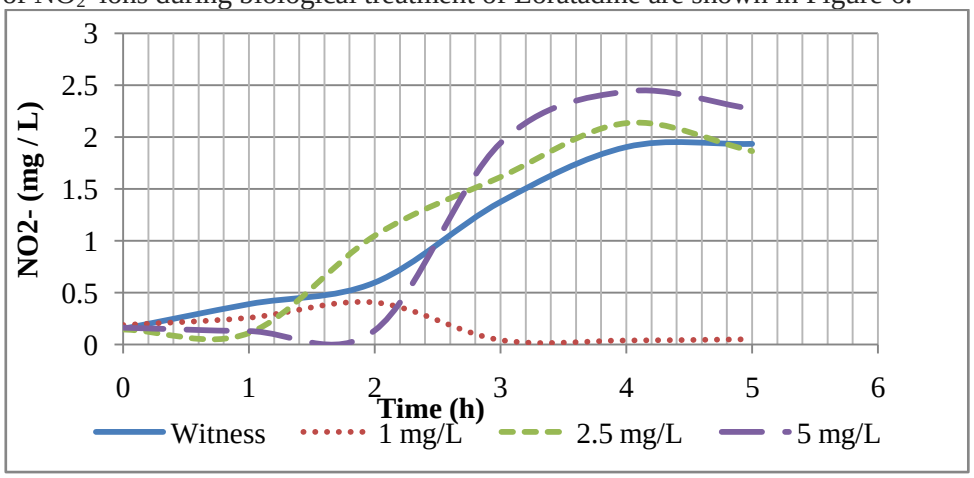

Figure 6: Evolution of nitrites during treatment as a function of Loratadine concentrations.

After the addition of Loratadine, an increase in concentrations of 2.5 and 5 mg / L is observed after one hour of treatment but after 4 hours a decrease is observed. The concentration of nitrite ions increases during the treatment for the control and does not exceed the value of 8 mg / L. At the concentration of 1 mg /L a decrease is observed beyond 2 hours of treatment. The decrease in the concentration of NO_2^- is due to its reaction with the organic matter added to form other compounds and this has been noticed by other researchers on chlorine which reacts with organic matter to form trihalomethanes which can reach several hundred mg [12].This explains a toxic effect of Loratadine on nitrifying bacteria [13]

3.7 Aromaticity

The variations of the aromaticity during treatment of Loratadine are represented in Figure 7.

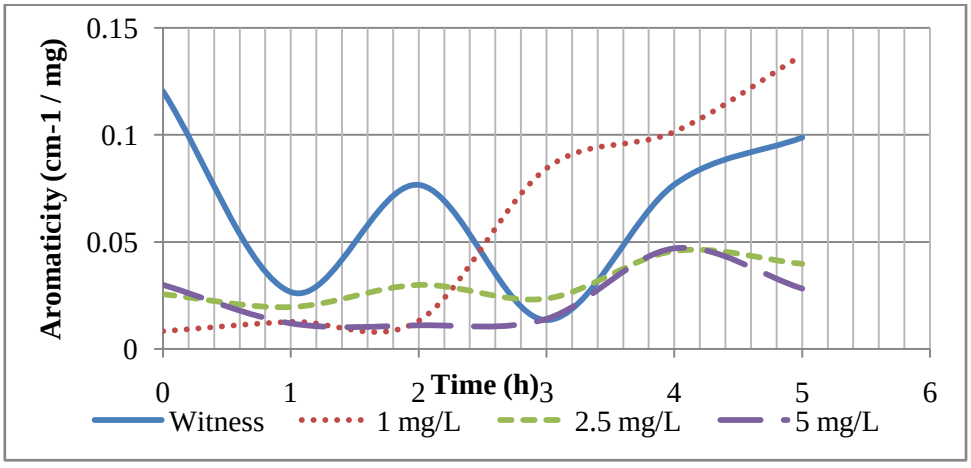

Figure 7: Evolution of aromaticity during treatment as a function of Loratadine concentrations.

After the addition of drugs, the aromaticity decreases for all Loratadine concentrations. During the treatment the aromaticity oscillates between the values of 0.01 and 0.12 for the control test. The aromaticity increases for Loratadine concentrations beyond 2 hours of treatment.

The SUVA index provides information that is often correlated and related to the hydrophobic and / or acidic nature of the organic matter. Thus, some major features can be synthesized. The molecular weight of the organic matter is correlated with the aromaticity measured by SUVA as observed by some authors on effluents of the WWTP or [14-17] on humic substances. Thus, the more aromatic molecules are generally of larger size.

Conclusion

Drugs play an important role in the complexassion of metals and ions present in wastewater but also in the retention and solubilisation of certain organic materials. Antibiotics are very toxic to bacteria and other microorganisms (from the environment, they can contribute, in the environment, to the increased resistance potential of mutant pathogenic bacteria. The functioning and efficiency of biological purification of urban wastewater can be compromised both by the flow and/or the nature of the drug substances present in the wastewater. The activated sludge biological process is suitable for the treatment of drugs according to their concentrations but it is not in a position to adequately treat this type of pollution as shown in this study. It is therefore necessary to envisage a more effective treatment in order to eliminate these compounds and their degradation products upstream of the purification plants and, if possible, a qualitative and quantitative analysis of these products is necessary.

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