Aquatic plants as a remediation tool for polluted water
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Abstract. The development of urbanization and industrialization represent two main factors leading to impaired quality of water bodies, directly or indirectly subjected to the action of pollutants. This study has followed the aquatic plants ability to reduce the pollutants present in water bodies. Therefore, the effects of aquatic plants water hyacinth (Eichornia crassipes) and water lettuce (Pistia stratiotes) on indicators: pH, turbidity, Chemical Oxygen Demand (COD), Biochemical Oxygen Demand (BOD), Total Nitrogen (TN) and Total Phosphorus (TP) have been studied at a wastewater derived from a poultry farm for a period of 40 days and an indicator of efficiency versus time has been represented. The obtained results have revealed the plants efficiency on the analyzed indicators, being emphasized that each group behaved differently. Due to the accelerated growth rate, these plants are one of the renewable energy resources of the future.

Key Words: water hyacinth, water lettuce, efficiency index, bioaccumulation, water pollution.

Introduction. Natural water is a crucial source on the way to a sustainable future. Given that worldwide water resources are increasingly scarce and highly polluted as a result of its unsustainable use, of population growth and as a result of inappropriate infrastructure, increasingly more countries have taken stringent measures to protect the environment against negative effects of pollutants, developing norms and standards for the design and construction of wastewater treatment plants (Ionescu et al 2015a; Roman 2016). Also, the worldwide energy crisis has led to finding and implementing of unconventional methods of wastewater treatment, methods that rely on the use of plants with increased bioaccumulation capacity of pollutants. Bioavailability and toxicity of pollutants is influenced by continuously varying the chemical composition of water as a result of anthropogenic emissions (Ionescu et al 2015b).

A solution for the treatment of the wastewater resulting from industrial activities, sanitary and storm ponds is represented by the designing and building of ponds to accumulate these waters in order to release the physical, chemical and bacteriological load (Radu et al 2015).

A particularly effective method for wastewater treatment is the introduction of some exotic species of aquatic plants that have an increased yield of bioaccumulation and bioconversion along with native species, significantly contributing to the treatment process (Bornette & Puijalon 2011).

According to studies presented in the literature, among the aquatic plants that have high bioaccumulation capacity, the water lettuce (Pistia stratiotes) and water hyacinth (Eichornia crassipes) are mentioned (Dixit et al 2011; Wanga et al 2012).

These plants have excellent properties to metabolize and absorb pollutants from various aquatic environments and because of their rapid growth rhythm they both are one of the renewable energy sources of the future (Sinha et al 2009; Liu et al 2008) and a possible source of food and medicines (Tulika & Mala 2015).

An impediment in the use of aquatic plants is that harvesting is mandatory until November in our country, because the plants die if the temperature falls below 5 °C, and furthermore nutrients accumulate in plants can be reinstated circuit leading to warping water (Liu et al 2008; Sajna et al 2007; Radhika et al 2012).

In this paper, a pilot-scale experiment has been conducted on the action of water hyacinth (Eichornia crassipes) and water lettuce (Pistia stratiotes) plants on wastewater pollutants resulted from a poultry farm.

Material and Method. Young aquatic plants have been purchased from specially designed ponds of a private plant breeder, in which different plant species are grown under optimum conditions.
Water samples have been collected from the treatment plant of a poultry farm, and experiments have been performed in glass vessels (35 x 35 x 30 cm). Initially, in order to adapt to the new environment of aquatic plants, the glass vessels were filled in with tap water and plants, being placed for 5 days in a natural light. The reagents used were of analytical purity, solutions were prepared with doubly distilled water.

**Experimental procedure.** Three experiments have been conducted (the dishes were labeled as I, II, III and IV) using the two species of plants, with pots being labeled as follows:

- I - control (using wastewater only);
- II - using wastewater and adding 4 stems of water lettuce;
- III - using wastewater and adding 4 stems of water hyacinth;
- IV - using wastewater and adding 2 stems of water lettuce and 2 stems of water hyacinth.

The amount of wastewater for each type of experiment was 30 L, recycling it and thus ensuring its homogeneity of the pollutants. The water volume has been kept constant by adding distilled water throughout the experiment.

The experiment lasted for 40 days (June-July) and water samples have been collected weekly, analyzing the following parameters: pH, turbidity, Chemical Oxygen Demand (COD), Biochemical Oxygen Demand (BOD), Total Nitrogen (TN) and Total Phosphorus (TP).

**Results and Discussion.** Following experiments and based on the obtained data, the efficiency of the biological treatment has been interpreted, by representing the efficiency index versus time. To calculate this index, the following formula has been used:

\[(EI) \% = \frac{(C_m - C_p)}{C_m} \times 100\]

Where: EI represents the efficiency index;
- \(C_p\) is the concentration of sample to be analyzed;
- \(C_m\) is the concentration of the blank.

In the Figures 1-6 the efficiency index for each analyzed parameter is represented.
Following the experiments and the correlation of the obtained data, we found out that:
- in Figure 1, for the pH, there is a different variation of the efficiency index in the experiment III, in other cases the variation is similar, recording a stabilization of the pH in day 24 of the experiment;
- in Figure 2, there is a different variation of the efficiency index, related to a significant increase in turbidity due to the formation of large quantities of algae and aquatic micro-organisms, this phenomenon being reduced from day 30 in experiments using single plant species; in case of experiment IV, algae and aquatic micro-organisms were present in significant quantities by the end of the experiment;
- Figure 3 shows the efficiency index varying throughout the experiment, correlating with the growth of plants, and evidencing the ability to bioaccumulate; it is noted that index reaches a maximum efficiency of about 80% in all three cases;
- in Figure 4 the efficiency index is similar in all three cases, the variation of biochemical oxygen demand is slightly different for the experiment in which both plants are present, due to the dynamics of absorption of substances in water;
- the efficiency index for Total Nitrogen (Figure 5) shows a significant decrease on the 12th day of the experiment, this being due to reactions that have occurred, leveling off by the end of the experiment, being approximately 90% at day 30, when the ability to bioaccumulate significantly decreases;
- in Figure 6, the efficiency index of total phosphorus is optimal to day 24 in all three cases, after which the ability to bioaccumulate decreases similar to total nitrogen.
For a more detailed assessment of the relationship between the quality parameters, Cluster Analysis (CA) has been used (Figure 7), who providing details of similarities between groups of parameters.

![Figure 7. Cluster Analysis of the quality parameters](image_url)

From CA we can observe an association of nutrients, behavior also observed for the parameters describing the organic matter content. pH and turbidity are another group shows the association with the monitored indicators.

Following the contact between polluted water and aquatic plants (water hyacinth and water lettuce), the concentrations of pollutants have been gradually reduced, these constituting themselves as food for plants.

**Conclusions.** Following the conducted experiments, it is noted that the plants used - water lettuce (*Pistia stratiotes*) and water hyacinth (*Eichornia crassipes*) have an increased potential to extract pollutants from eutrophic waters, thus having a significant contribution to the advanced wastewater treatment process.

The experiment reveals that each group used behaves differently, thereby influencing the absorption dynamics of substances in water, and due to the accelerated growth rate, these plants are one of the renewable energy resources of the future.

**References**

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